Under the patronage of the
Federal Ministry of Works and Housing

Under the auspices of the
Federal Ministry of Information and Culture
National Commission for Museums and Monuments

NIGERIA

CENTRE FOR EARTH CONSTRUCTION TECHNOLOGY

CECTech

July 1994

In collaboration with the
French Ministry of Foreign Affairs
Cultural, Scientific and Cooperation Section of the French Embassy in Nigeria

MINISTRY OF INFORMATION AND CULTURE
NATIONAL COMMISSION FOR MUSEUMS AND MONUMENTS

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MINISTRY OF FOREIGN AFFAIRS
Section for Development and Scientific, Technical and Educative Cooperation
Cultural, Scientific and Cooperation Section of the French Embassy in Nigeria
With the Technical Assistance of CRATerre - EAG
International Centre for Earth Construction School of Architecture - GRENOBLE

MINISTRY OF INFORMATION AND CULTURE
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CENTER FOR EARTH CONSTRUCTION TECHNOLOGY CECTech

FRANCO-NIGERIAN COOPERATION PROGRAMME
JULY 1994

Creation and Edition

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Finally, we shall not forget the numerous participants in different courses and workshops organized at the CECTech as well as their respective institutions or companies, the 1000 visitors who have visited the Jos Museum and subsequently visited different sites and especially, those who, recently, have expressed their desire to establish a collaboration with CECTech : Yaba College of Technology, Lagos, Technical College, Bukuru, Modespro Nig. Ltd., Evangelist Church of West Africa (ECWA), Defence Industry Corporation (D.I.C.), Kaduna.

Summary

Preface

The driving role of the N.C.M.M

In the last thirty years, the National Commission for Museums and Monuments in Nigeria has developed a knowledge and experience in the area of traditional construction in Nigeria and particularly on the use of soil as a first hand material for modern constructions. The work achieved on a daily basis by the N.C.M.M. on the preservation of heritage built with Nigerian soil is directly linked to the need for improvement of the national housing reserve.

As a result of the economic crisis which the country has been faced with for the last ten years as well as a high shortage of housing at the national level, the N.C.M.M. launched a programme whose objective was to explore and develop earth construction and its economic potentialities with a view to finding solutions - amongst others - which would reduce this dramatic shortage.

Having identified advantageous technologies which were beneficial at the technical, economic and cultural levels, the N.C.M.M. decided to establish a Center for Earth Construction Technology, CECTech in Jos, Plateau State. This center was established with the collaboration of the French Government, on the basis of a cooperation agreement with the Cultural, Scientific and Cooperation Section of the Embassy of France in Nigeria. The CECTech of Jos expects to be part of the National Policy on Housing decreed in 1991 whose objective is to provide housing for all by the year 2,000. These houses must not only be decent but also affordable.

Consequently, the activities carried out by the CECTech constantly apply the recommendations of the Center for Human Establishments (Housing) of the United Nations declared by its General Assembly in December 1988 and published in the document "Shelter for All, World Strategy By the year 2 000". Subsequent to this declaration, the Center in Jos acts as a documentation center specialised in earth construction which develops professional training, erects building samples (houses and public infrastructure), organises different promotional activities and provides advice and technical assistance.

Five years after the establishment of this programme of cooperation, one can affirm today that remarkable results have been obtained which contribute positively to the opening of a new path for a renewal in earth construction which will be useful for housing a great number of people in the country. This will be done with a view to facilitating the development and mastery of local construction and to progressively ensuring autonomy and the capacity to construct a house which is affordable to the Nigerian population.

Beyond its immediate results, the CECTech has started to make a very important impact, mainly in Plateau State, but also, gradually, in many other areas in the country.

Fig. 1: Mbari Shrine, Igbo architecture, Jos Museum

The new professional network on earth construction established as a result of training sessions which were successively organised in Jos by the CECTech during these past three years, is growing constantly. This network develops its activities by applying technologies which have been demonstrated and developed by CECTech which has already completed some very big projects.

Among these projects which have been carried out by the CECTech or which have received its technical assistance, can be mentioned the very recent Crafts and Cultural Center for the Council for Arts and Culture of Abuja, built in our Federal Capital. Technical assistance was equally provided in the implementation of big projects which are now under construction : 100 houses for the Taraba State Government and a secondary school at Barakin Ladi, near Jos. Another important housing programme, in Kebbi State is about to be started under the supervision of a participant at one of the national courses on earth construction technology organised in Jos.

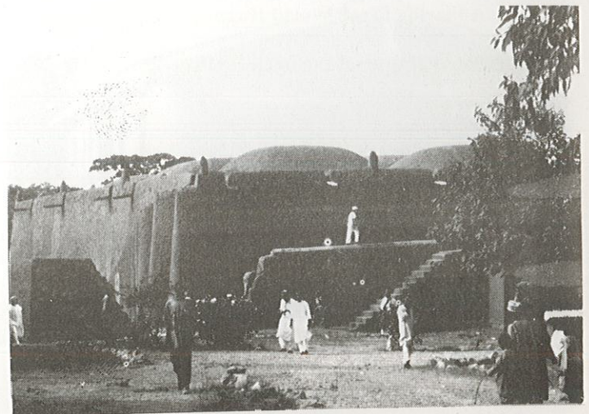

Fig. 2: Zaria Mosque, Hausa architecture, Jos Museum

Fig. 3: Centre for French Teaching and Documentation, full view of the entrance; designed and built by CECTech, Jos

The African Centre for Development and Strategic Studies. **ACDESS has commenced** the construction of its offices at Ijebu **Ode in Ogun State.** The Evangelical Church of West Africa. **(ECWA) is in the process of building** offices for an agricultural **project (1500 m²)** at Bukuru, near Jos. The equipment for the **production** of compressed earth bricks imported from Europe, **added to the** increasing number of locally made presses now **provides a capacity** for building an equivalent of 4,500 housing **units per year.** Undoubtedly, this growing activity has started to **assume a non negligible** importance at the national level.

However, it is important to note that this technology, which has developed at a fast pace, has to be adequately mastered in order to guarantee optimal quality in finished products. Particular attention must be accorded to the outcome of researches which have been undertaken, both in the area of adapting scientific and technical procedures to present Nigerian conditions and realities as well as the improvement of the quality of the architectural design.

Fig. 4: Demonstration low-cost house, designed and built by CECTech, Jos

It will be essential to circulate results of research works and scientific knowledge through the publication of technical guides and rules of the art of construction. The local production of a high quality specialised equipment must also be explored and encouraged.

It is also of paramount importance that institutions which have already expressed their willingness to develop a specialised training either at the university or professional level should be supported. The present activities of CECTech of Jos must be considered as an initial stage in the future development of earth construction which would be positively beneficial as regards financial resources at the national level, in order to guarantee an efficient and durable development of this very promising technology.

The future of Nigerian earth architecture for housing and public infrastructure is open henceforth. A larger partnership and professional network must be developed and consolidated, involving a larger range of governmental institutions at the federal and state levels, and even more, professionals, Departments of Construction and Architecture of our Universities, Research Centers, Technical Colleges, Polytechnics in order to:

a) multiply operational competence;
b) increase the capability to undertake bigger projects ; and
c) ensure an efficient technical and economic development of the new Nigerian earth construction method.

The National Commission for Museums and Monuments is proud to contribute its own quota to the present rebirth of earth construction technology in Nigeria, linking its efforts to those of other Federal institutions responsible for housing (Federal Ministry of Works and Housing, for example) who are also interested in the potential and production of local construction materials in the country.

We shall conclude here by emphasizing again the necessity to act, through all means available in the country, towards the World Strategy for Housing By the year 2,000 and within the scope of the National Policy on Housing. The necessity to reinforce the link between Culture and Development is a strategic objective which was clearly expressed in the closing recommendations of the last 7th International Conference on the Preservation of Earth Architecture "Terra 93" held in Portugal. As a result of this very important orientation, the N.C.M.M. has already assumed its own responsibility and mobilizes its efforts on this urgent question of "housing for all". The slogan of our institution, "a great heritage for a greater future" is more real than ever and we are certain that the potentials of our earth architectural culture can provide solutions to the housing needs of the Nigerian populace.

Doctor Yaro Gella, Director General of the N.C.M.M.

A desire of cultural institutions

This project is founded on the basis of the existence of an architectural heritage of exceptional importance and variety in the whole of the Nigerian territory having a great potential to resolve housing problems faced by the majority of the Nigerian population.

Backed up with a know-how and developed capabilities for thirty years now and conscious of its institutional role, the N.C.M.M. understood that, through its working method linking culture and development, it could offer its own contribution to the problem of providing houses for a greater number of people by positioning itself in the wake of orientations provided by the "World Strategy of Housing by the year 2,000" declared by the General Assembly of the United Nations. These same orientations were recaptured in the "National Housing Policy" : "Housing for all by the year 2000" published by the Nigerian Government in February 1991.

Fig. 5: St. Bartholomew Catholic church in Wusasa, Zaria

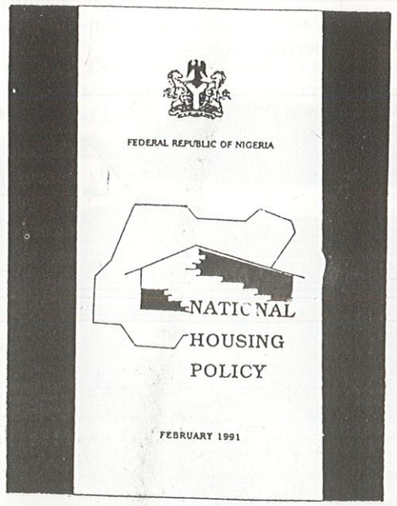

Fig. 6: Cover of the publication on National Housing Policy of Nigeria

Definition of a programme of action

The elaboration of a programme based on a notion of "traditions and modernity" of earth architecture in Nigeria necessitated the definition of a procedure and specific working methods. Indeed, a simple technological transfer, without considerating of the stronger cultural and social peculiarities of the country, was impossible. It was not possible either, to undertake a project of national dimensions, with a very vast and diversified territory.

The project which is oriented towards achieving and modernising of earth construction has as its main guidelines:

- the study of traditional and contemporary construction cultures : analysis of local methods of production, identification of know-how and the evaluation of their potentials for eventual application to a modern construction of a low-cost house;
- the development of new technologies and the improvement of existing techniques and their adaptation to resources and requirements of public institutions, building professionals and the general public;
- the necessity for specialised training, both in the academic and professional domains, for the staff of NCMM with the support of scholarships in France, and through the organisation of seminars and courses in Nigeria for university students, architects, contractors and site technicians ;
- setting up brickyards, commencing on-site production-training, use of reference architectural works with a view to improving the potentials of earth construction in Nigeria.

Initial results

Within the first two years of the project, a suitable site (Jos National Museum, and Plateau State), was identified to execute the first actions linking mainly information and professional training, demonstrative construction and research. It was also confirmed at the end of these two years that earth brick construction is a reliable and very economic solution for building houses that are affordable to the majority of Nigerians.

The seminars and training sessions were open to institutions responsible for building, teaching construction and architecture and for scientific and technological research; the private sector (architects, engineers, contractors), and government parastatals. This led, not only to a better definition and orientation of the project, but also helped in gradually winning the support of a greater number of associates.

The activities carried out by the project aroused a lot of interest and by 1991, concrete results were already observed. The use of earth bricks is rapidly being adopted by many contractors. The Department of Architecture of the University of Jos is presently introducing a specialized course in this domain. In addition, the government parastatal, "RURCON" organises enlightenment sessions, while mechanical construction workshops in Jos manufacture and sell earth brick presses which, by the end of 1991, attained a production capability of 400 low-cost housing units per year.

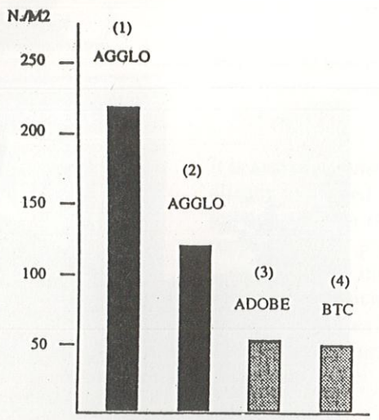

Fig. 7: Comparison of cost of various types of walls (June 1991)
1) Concrete block (6") coated on two sides with cement and sand mixture in reinforced concrete frame. 2) Concrete block (9") coated on two sides with cement and sand mixture. 3) Adobe of 20 cm coated on two sides with cement and sand mixture. 4) Compressed earth brick stabilized with 4.4% of cement.

Creation of CECTech

The experience acquired through carrying out the project, added to the opinion of various associates and the regular follow-up on various developments necessitated some reflection, analysis and evaluation. Consequently, it became possible to define the theoretical and practical needs and to formulate a strategy for action which would guarantee adaptation to local context, coherence and efficiency in the continuation of the programme.

Following the setting up of the initial base of an "earth specialization", mainly in Jos, and in response to various concrete requests, a resource center accessible to a large number of people was created. The CECTech was designed as a center with competent staff and specialized equipment, providing information, training, expertise and technical services, while still continuing its promotional and research activities as well as the follow-up on results of activities already carried out.

Right from its inception in September 1992, the CECTech has clearly been very successful. The center has already received 1500 visitors, more than 50 official requests for technical assistance, while within the space of one year, 70 building technicians (architects, engineers, contractors,...) have been trained through intensive courses which are paid for, and more than 50 masons and brickmakers have been trained on site. The dynamism of the center was also proven by their being awarded a big project at Abuja involving the publication of an initial technical document and a semi-permanent supervisory role.

Fig. 8: Centre for French Teaching and Documentation, overall view; designed and built by CECTech of Jos

The birth of a regional "earth specialization" for low-cost housing

Fig.9; Demonstration low-cost house, designed and built by CECTech, Jos

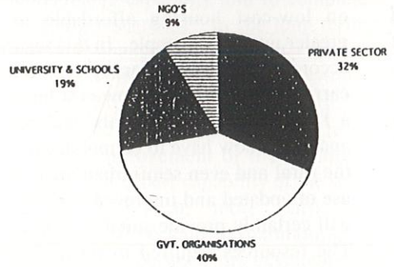

Fig. 10: Distribution by sector of activity of 70 participants in the intensive courses organised by CECTech Jos in 1993

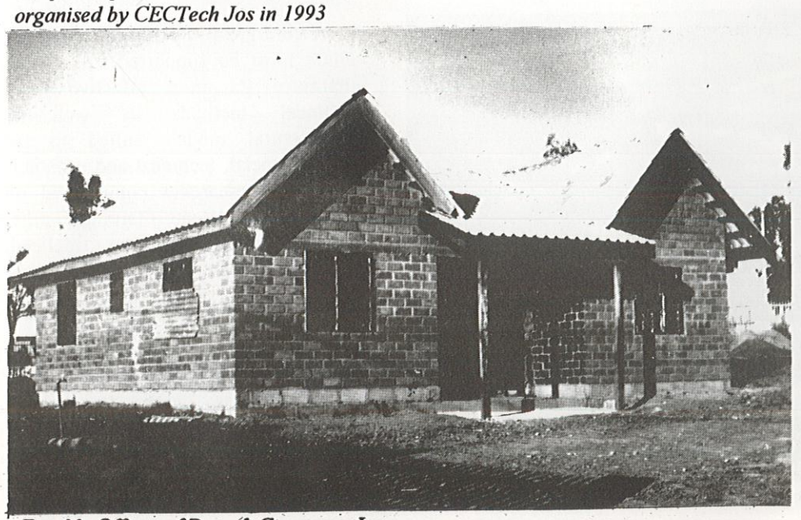

Fig. 11: Offices of Dunsek Company, Jos

CECTech, through its creation and the multiplication of activities, has brought about the development of an earth specialization in Nigeria with a construction capacity in the whole Federation, presently evaluated at about 4,500 low-cost housing units per year. This capacity increases daily with an unceasing growing demand.

Though most of the projects accomplished are still on a reduced scale, increasingly, bigger projects are presently being considered and executed. For now, the center is more active in the very rapid acceleration of development in the private sector and Government parastatals than in public construction programmes.

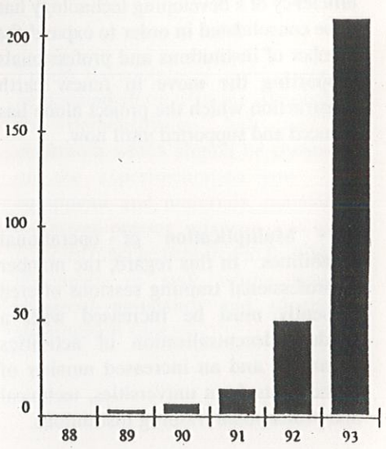

Fig. 12: Evolution of the number of locally manufactured presses in Jos.

Subsequently, many training organisations, universities and professionals wish to integrate earth construction into their programmes and have made their requests for technical assistance known to the CECTech.

Though many projects are undertaken by participants who previously participated in training sessions and receive technical assistance from the center, many of the construction works carried out are still done on a feeble technical base as a result of the very strong individual dynamism of Nigerians and as a result, problems relating to the quality of these buildings or to their real economic reliability are still encountered regularly.

A new stage ; towards an impact at the national level

The path to the setting up of a national "earth specialization" in Nigeria, which will lead to the development of low-cost housing and a modern earth architecture, is now open. The initial and pilot development of this specialization in Jos, can be gradually extended to a more vast territory thereby obtaining higher economic, social and technical results. In this guise, several essential guidelines can already be mentioned:

Fig. 13: Training is essential for the multiplication of competence; participants in the 1st intensive course organized by CECTech Jos in June 1993.

1- Supervision of buildings and the quality of materials used as well as the improvement of the dependability of locally manufactured production equipment. This is because the efficiency of a developing technology has to be consolidated in order to expand the number of institutions and professionals supporting the move to renew earth construction which the project alone has induced and supported until now.

2 - Multiplication of operational capabilities. In this regard, the number of professional training sessions offered presently must be increased with a gradual decentralisation of activities organised and an increased number of participants from universities, technical and professional training institutions.

3 - As soon as possible, while still providing technical assistance and training support, delegation of architectural reference activities to operators of the skilled network formed through the project or to other federal institutions responsible for housing and town planning (e.g. Ministry of Works and Housing). This will invariably accelerate the availability of experimented professionals on the market.

4 - Focusing the dynamics of the project on low-cost housing affordable to a greater number of people. In this regard, according to a revelation by researches carried out on Nigerian low-cost houses, a larger range of materials, technique and know-how have to be mobilized. In the rural and even semi-urban areas, the use of updated and improved clay bricks will certainly provide suitable solutions. The resources required to set up high-performance systems of assistance in automated construction must equally be considered.

5 - Accord great importance to research which must be supported in order to guarantee the most effective tools, technical methods as well as architectural models suited to the cultural, social, technical and economic context. Researches commenced on housing for Plateau State and other technical areas must be finalized, published and circulated. Assistance to universities and various research centers in the country aimed at developing other research centers on this question of low-cost housing must be reinforced.

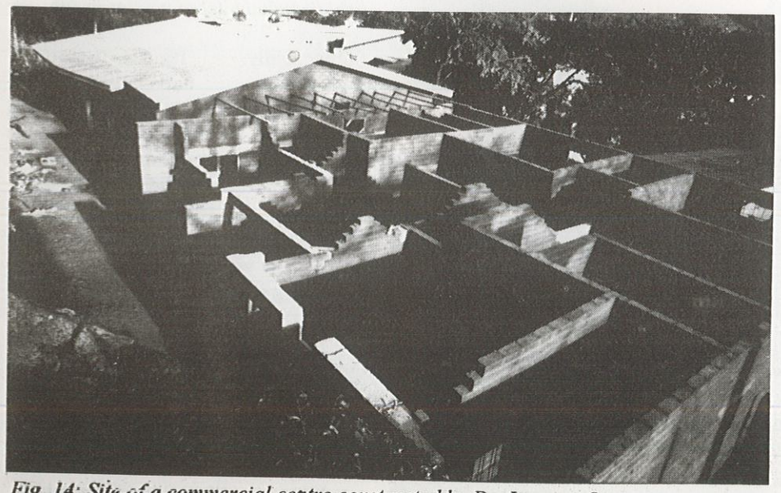

Fig. 14: Site of a commercial centre constructed by Dr. Lawson, Jos

The necessity for adequate resources

In order to introduce this new stage, it is desirable to multiply and improve the activities and services of CECTech. In this regard, much more human, financial and material resources are required. Consequently, the Center of Jos must henceforth be prepared to present a programme of activities to national and international organisations who will be in a position to allocate the financial resources necessary for the proper functioning and reinforcement of its actions. This financial aid is also necessary to establish a partnership and collaboration with institutions who want to start their own programmes. This search for resources should be supported by the publication of a regular report of activities and results and must be understood as a priority action.

An increase in the number of staff employed by the center must be pursued vigorously in order to reinforce the working capabilities on ground. Professionals must be trained to take charge of construction and technical assistance programmes. This ground team will remove the burden of performing these type of activities from the executive staff of the center who will now concentrate on the management of the center, sourcing financial resources, training trainers, development of relations with other national institutions, international organisations and professional associates, as well as prospecting and elaboration of new opportunities. On the other hand, ethnologists and sociologists should be integrated into the team of the center to carry out research activities on housing.

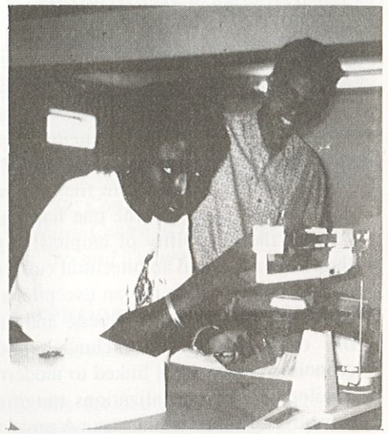

Fig. 15: Training of staff of CECTech in the soil analysis laboratry, Jos

An international technical assistance must be obtained to attain the transitory phase of the development of a reinforced autonomous capability and to complete on-going researches. In the long term, regular exchanges between the CECTech and other international organisations working in the same domain must be perpetuated. This should lead to a constant improvement of the technical mastery and expert capability of the staff of the CECTech; more particular attention will be paid to maintaining a good balance between the development of the ability of action of the center and the quality of its services.

Activities relating to experimentation and demonstration of various constructing and architectural possibilities in earth construction must be developed. This will be done while still trying to engage the interest of decisive institutions and professionals and also paying particular attention to the expectations and needs of the population in rural, urban and semi-urban areas.

Finally the equipment of the center must be updated along with the completion of the demonstration hall and one classroom which should be constructed on the experimentation site. New equipment and materials, manual and motorized presses, mixers, ..., as well as vehicles must be acquired to facilitate the movement of staff while providing technical assistance and supervising construction sites.

Fig. 16: Making of compressed earth bricks on the CFTD site.

A method for a development project

Identifying a promising potential

Right from the launching of the project in 1988, and as a result of the first exploratory mission, it became apparent that Nigeria is blessed in many respects with enormous potential in the area of earth construction; on the one hand as regards the possibility of emphasizing the constructive and architectural culture of the country which has an exceptional and lively quality and richness, and on the other hand, the technical and economic perspectives linked to modern development of specializations ranging from arts and craft to industry. A project could be founded and developed in both areas of "traditions" and "modernity". This observation of the great potential of Nigeria brings up a lot of possibilities for the project which are gradually better defined by paying attention to the demands of the environment.

Fig. 17: Low-cost house designed and built by CECTech. Demonstration of the construction and architectural potentials of compressed earth bricksin the building of houses.

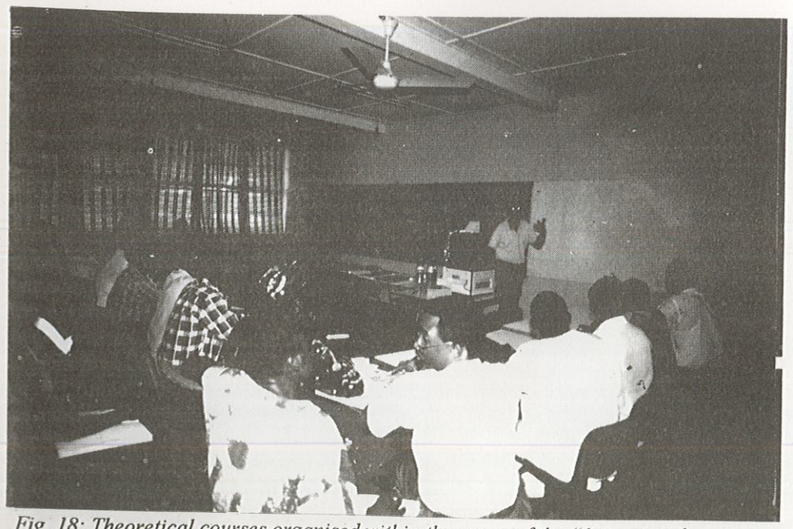

Fig. 18: Theoretical courses organised within the scope of the "1st national workshop", Jos 1990

Expand the number of participating members

The development objective of a project aimed at making a high impact very soon necessitates contacting a large number of participating members both in the public institutional sector as well as in the private enterprise sector. It is by emphasizing the cultural and social development role of the National Commission for Museums and Monuments- the initial and central partner- that this partnership opportunity can be contrived. The initial "workshops" and national seminars organised in Jos in 1990 and 1991, after an initial period of identification and establishment of contacts (end of 1988-89), brought about this sensitization and enlightenment of federal, regional, political, academic and professional institutions, on the potentialities and limits of earth construction technology. Reflective seminars held with participants at these initial informative sessions and the initial small constructions done for companies during these "workshops" which concretised a passage to the act of construction, equally benefited the project and led to a better understanding of the interest, expectations and needs of participants and numerous visitors.

Definition and introduction of a strategy

A great impact was made by undertaking initial activities for the promotional development of the technology through the construction of a brickyard and subsequent work on strategic sites in the city of Jos which were directly accessible to the public. Right from the phase of production of raw materials, numerous visitors from various origins representing the institutional sector and companies in Plateau State, have maintained a permanent and increasing request for information.

The follow-up attempts at a spontaneous appropriation of the technology and constructing and architectural models was as exhaustive as possible with the double objective of preventing a drift from quality and remaining attentive to the demands of the environment. Numerous discussions held on the production and construction sites with contractors, architects, site technicians, masons, labourers and clients led to the elaboration of an initial report:

- the technical and economic potentials of the technology is useful for providing solutions to the problem of producing moderate cost houses;
- the enlightenment and training of the institutional sector and company teams are compulsory in order to fill in the gap of knowledge and know-how regarding the proper use of the technology;
- the availability of production equipment on the local market at an affordable price, will meet the expectations of the professional world;
- the quality of constructions must be improved at the technical and architectural levels;
- the work practice must be developed through a maximization of independent research and under minimal .and informal conditions of acquisition of knowledge through indirect ways.

Based on this report, a strategy of action was defined which was aimed at guaranteeing the development of the technology under the most suitable conditions. This strategy simultaneously links the development of two sets of activities.

An initial set of activities proposed in form of services by the CECTech of Jos:

- technical, general and personal (consultation of documents) information;
- training on production of materials, project and site design for executives in the building sector (companies, architects, engineers, site heads) and on spontaneous or supervised operation sites;
- technical assistance and architectural development through the completion of reference projects, geotechnical advice, studies and technical advice to local press manufacturers.

A second group of activities involves the permanent supervision of construction sites and a close monitoring of the building sector, studies and research works. These indispensable activities will .nourish those of the first set and ensure the best conditions for adaptation of the technology to the environment with a better identification of intellectual and practical tools for maintaining a good level of quality of the production material and constructions.

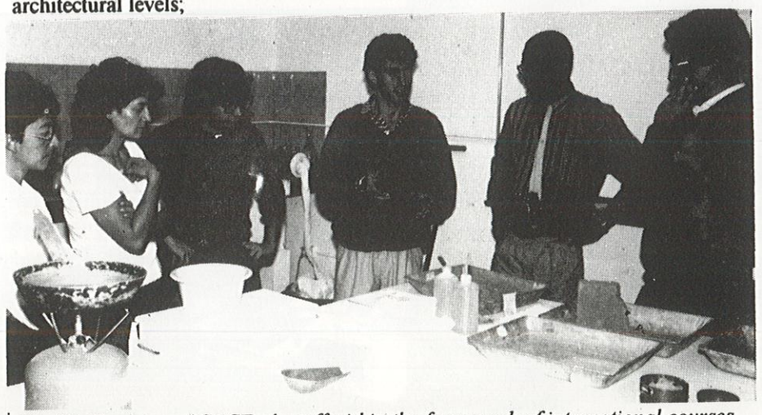

Fig. 20: Training of CECTech staff within the framework of international courses held at the Ecole d'Architecture de Grenoble

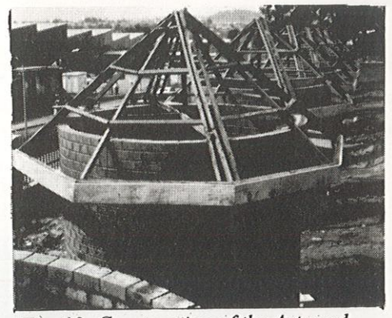

Fig. 19: Construction of the Arts and Cultural Centre of the Abuja Council for Arts and Culture.

Creation of a centre of excellence

It was decided that an action base be established in Jos, capital of Plateau State, which once consolidated will become a center of excellence and reference for operators. The choice of this site is justified by :

- the existence of a well structured team of professionals at the NCMM and the National Museum, Jos which also houses a museology school, a school of archeology and a museum of traditional architecture ;
- a dynamism in the area of building exhibited by architects and contractors interested in the development of new techniques using local materials.
- the existence of a University, (UNIJOS) in Jos, with teaching staff and students who are enthusiastic about the use of earth material for new construction and architectural applications ;
- a qualitative regional and monumental housing architecture which can constitute the grounds for a research on the building and architectural culture and its potentialities for new modern applications.

In conclusion, emphasis has always been placed on advanced training for local executives of the project and in particular, staff of the CECTech of Jos. Most of them have benefited from training scholarships in France through which they have attended intensive courses on the compressed earth brick technology where they were trained on laboratory analysis practices, acquiring expert capabilities and educational know-how which is used in the development of activities of the Center and the birth of earth specialization from the gradually consolidated action base of Jos.

CECTech of Jos

Objectives

The setting up of the CECTech, opened in September 1992, meets the multitude of requests directed to the NCMM by contractors, architects and engineers, private house owners and various scientific, technical institutions and local and Federal universities from the time the project "Earth Architecture" was launched. These requests expressed a set of needs, mainly for information and technical assistance.

In order to respond to these requests, the CECTech is designed as a Resource and Training Center on Earth Construction whose objectives are the following:

- the promotion of earth construction technology ;
- public enlightenment;
- training of professionals including teachers at different levels;
- technical assistance with a study and site advisory objective ;
- completion of demonstration buildings.

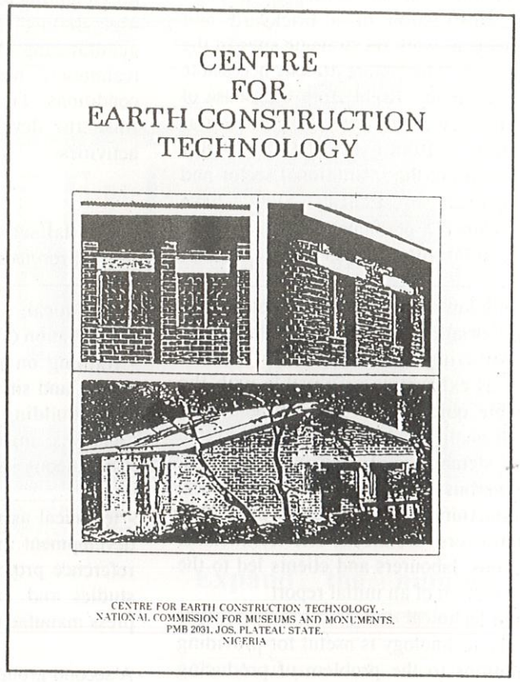

Fig. 21: Cover of a publication presenting CECTech, Jos

Resources

Staff : 15 persons are to this day officially employed by the NCMM at the Center. The "executive" staff have gone through specialized, university and professional training in France at the Ecole d Architecture de Grenoble.

Premises : the Center is set up in a wing of the building of the National Museum, Jos with 150 m² of space for offices, an architectural workshop, a library which is accessible to the public and a soil analysis laboratory.

Fig. 22: The documentation centre of CECTech

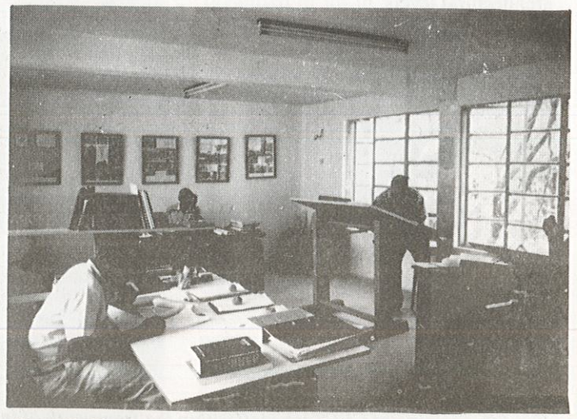

Fig. 23: The project design workshop of CECTech

In addition, the use of these materials for the construction of roofs in form of vaults and domes can be envisaged particularly in hausa building culture where roofing done in a technique of 'azara' and earth mixture have been perfected.

In the southern areas of the country, lighter construction typologies combining wooden structures using the regional essence of quality, and filling in with earth construction materials. eventually erected on piles to meet climatic and geophysical constraints in the region (swampy, mangrove soils), could be adapted while improving the traditional typologies of these areas.

Fig. 40: Houses designed and built by participants at the 1st National workshop

Fig 41: Demonstration building constructed during the 1st National workshop

Cultural considerations

The present aspirations of an evolution towards modernity have been met by the wide range of shapes which can be achieved, methods of building walls and roofs inspired by the regional architectural heritage, colours and texture of the materials, while proposing new architectural models and enhances cultural continuity. This aspect is without doubt decisive and has already played an important role in the extent and rapidity of spontaneous appropriation of the earth construction technology introduced by this project.

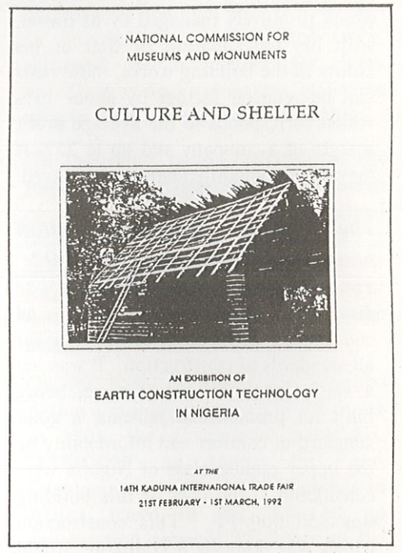

Fig. 42: Publication of the NCMM for the purpose of the Kaduna International Trade Fair, 1992

Diversity of uses

Earth construction techniques are suitable for the construction of all types of works and housing construction programmes or public buildings. Projects done in Jos which cover surface areas ranging from 10 to 1 000 m² are a proof of this fact. Though, for the moment, only one storey buildings have been erected, it is absolutely possible to construct multi-storey buildings without having to use any particular methods of consolidation.

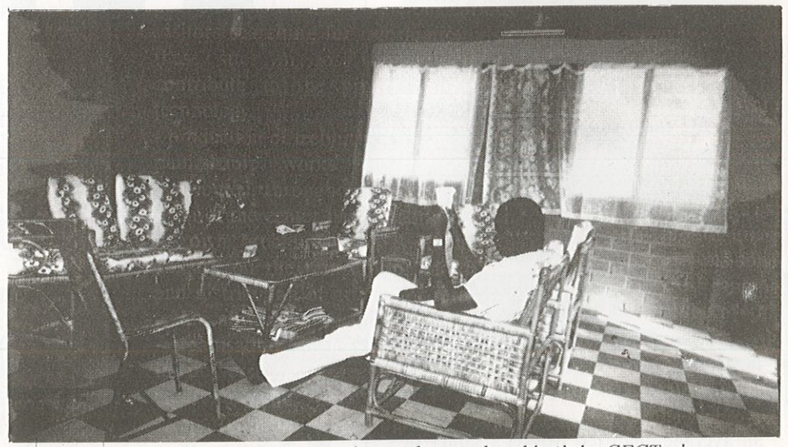

Fig. 43: Interior of the demonstration house designed and built by CECTech

Economic advantages

Possible savings:
For a low-income house with basic amenities, in an urban zone, it is possible to save money when compared to the use of concrete blocks with similar amenities. These savings can be as high as 20%. Compressed earth bricks construction by a company is therefore realistic and is done at an average cost of 450 FF/m² as against 570 to 600 FF/m² in concrete blocks (difficult to use current rates in Nigeria now for this purpose).

In the rural area, clay brick construction will still be more economical since its cost price could be as low as 350 FF/m².

In the case of a building construction which is entirely managed by its owner, with his participation or that of his family in the building works, these costs can be reduced further by about 15% which corresponds to the average profit margin of a company and up to 25% if the cost of unqualified labourers is saved.

The cost of the demonstration house constructed in Jos in 1992

This project was designed to demonstrate the suitability of compressed earth brick technology for all standards of construction. It was not a very economical house since, being built for promotional reasons, a good standard of comfort and affordability by the upper middle class of Nigeria were considered. The cost of this building was 850 000 FF. This construction which was done by a company, would have cost 1 000 000 FF or 700 FF/m². When compared to a similar construction in concrete blocks, a saving of 11% was made.

Comparison of costs per m² of wall, in an urban area, in Jos

With the earth construction technology, savings of more than 50% can be achieved on the price of a m² of wall in relation to the concrete block construction. These savings can still be higher in rural areas, and could attain 70 to 80%. Savings on cement per kg/m² of wall constructed are equally very high for earth construction techniques, which is decisive in a country where the cost of cement has reached crippling prices (in 1993, a bag of cement cost 180 Naira for an average qualified worker's salary of 1,500 Naira/month).

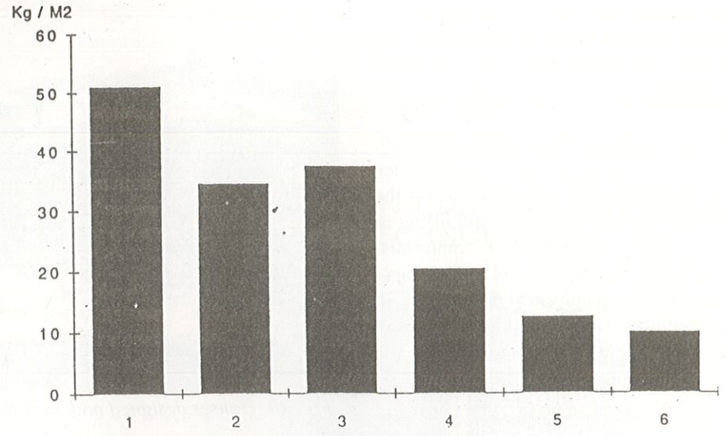

Fig. 44: Quantity of cement required for the building of a m² of various types of walls

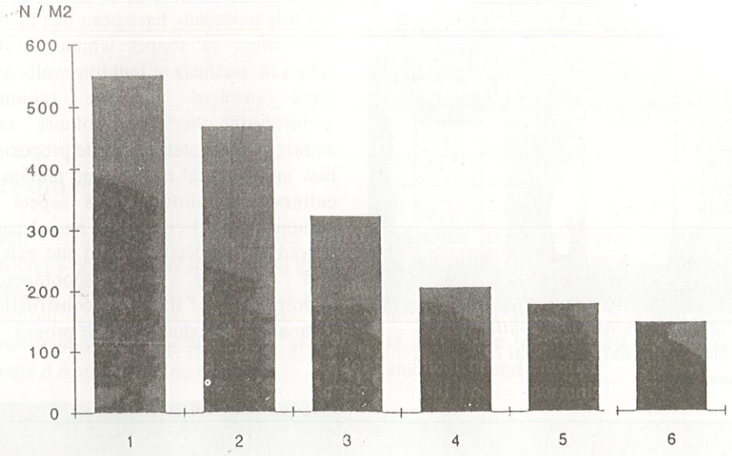

Fig. 45: Costs of construction of a m² of various types of wall.

1 - Concrete block (6") coated on two side with cement and sand mixture in reinforced concrete frame.
2 - Compressed earth brick stabilised at 4.4% in reinforced concrete frame.
3 - Concrete block (9") coated on two sides with cement and sand mixture.
4 - Compressed earth brick stabilised with 8.8% of cement.
5 - Compressed earth brick stabilised with4.4% of cement.
6 - 20cm adobe wall coated on two sides with cement and sand mixture..

The outcome of the activities of the CECTech

The impact in Jos and the regional area

Appropriation of the technology

Training activities and demonstration constructions done on sites presenting exceptional designs has aroused great interest and had a considerable impact in Jos and its environs where a spontaneous and rapid appropriation of the compressed earth brick technology can be observed.

In the public sector : following the construction of the Center for French Teaching Documentation" building in Jos in 1992 by the Plateau State Ministry of Education, and the completion of a second 4-room house, the Governor of the State gave his total support to the idea of earth construction. The public sector has ordered another construction of 8 housing units for civil servants for the local government of the town of Bokkos.

In the private sector : since 1991, local mechanical workshops have manufactured earth brick presses. B&B Brother company produces small manual presses which it distributes to the local market presently representing an average rate of 150 presses a year. This production, added to those of other small local workshops, contribute to a local production capacity of low-cost houses equivalent to 1500 housing units.

Work on numerous small sites have taken off in Jos and its environs which demonstrate an operational dynamism and a real appropriation of the technology in the professional domain. The number of private sites are on the increase along with constructions which range from economic (40 m²) to standard (100 to 300 m²) buildings. The demonstration house constructed by the Center was reproduced by a private constructor. A 1000m² commercial center was constructed and opened in Jos in 1993 while organisations such as Evangelical Church of West-Africa (ECWA) is currently constructing its offices (1500 m²) for an agricultural project in Bukuru, near Jos. A secondary school comprising of 12 classrooms, a dormitory and a cafeteria is under construction in Barakin Ladi. Today, the Center has been requested to provide advisory and technical assistance on bigger projects (100 housing units in Lagos).

Extension of its training activities

Several national courses on the earth construction technology have successively been organised in Jos, in 1990 and 1991 which are mainly accessible to decision makers, architects, engineers, university lecturers and construction technicians. The opening of CECTech in 1992 led to an increase in these training activities. Consequently, in 1992, a course for decision makers, professional and high level personalities in universities was organised twice, followed by a course for work coordinators and technicians managing sites in local and regional companies.

On the other hand, UNIJOS, at the initiative of the head of the department of Architecture and teachers trained during the seminars, inaugurated a specific course for earth construction and for this purpose, part of the technical documentation provided by the programme is used.

On the basis of knowledge acquired during a training organised by the center in 1991, the government parastatal, "RURCON", an Agency for Rural Development of Christian Churches in Africa, based in Jos, has set up sensitization sessions (2 days) on the compressed earth brick technology using the technical documents provided by the project.

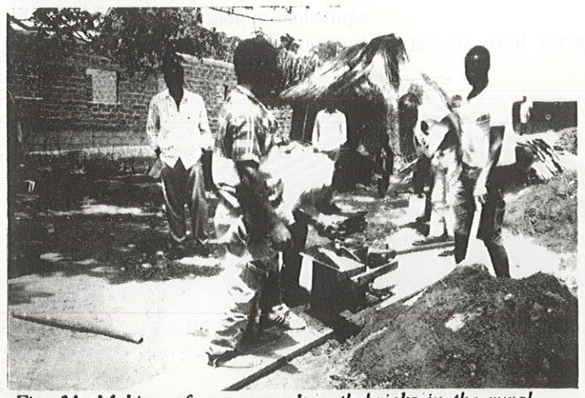

Fig. 31: Making of compressed earth bricks in the rural area, Rayfield

Fig. 32: First private construction in Jos

The birth of an "earth" specialization

The birth of a local "earth" specialization whose impact extends to the regional and even national level is confirmed by numerous activities in Jos combined with the operational dynamism of companies, translated into the manufacture and increasing distribution of locally manufactured presses and the proliferation of construction operations.

It also proves the firm conviction of the professional environment that the proposed technology could offer reasonable solutions to the need for low-cost houses for the masses. Investment in this area has come mainly from the housing sector on a large scale as well as the public works sector, thereby confirming the operational reliability of an economically profitable market for contractors.

Fig. 34: Stocking earth bricks in a village

Impact at the National level

Successive inaugurations of the initial key demonstration buildings - the "Center for French Teaching and Documentation" and the modern 4-room house, the construction of an exposition and information pavilion at the Kaduna Trade Fair in 1992- were attended by several Federal institutions (Ministries of Works and Housing, Education, Industry and Culture). These events were covered in a programme broadcast by the national television which also broadcasts at prime viewing time, a film of 15 minutes duration produced in France. The works and activities of CECTech Jos have been officially exemplified several times by the governmental authorities as a model of contribution to the National Housing Policy.

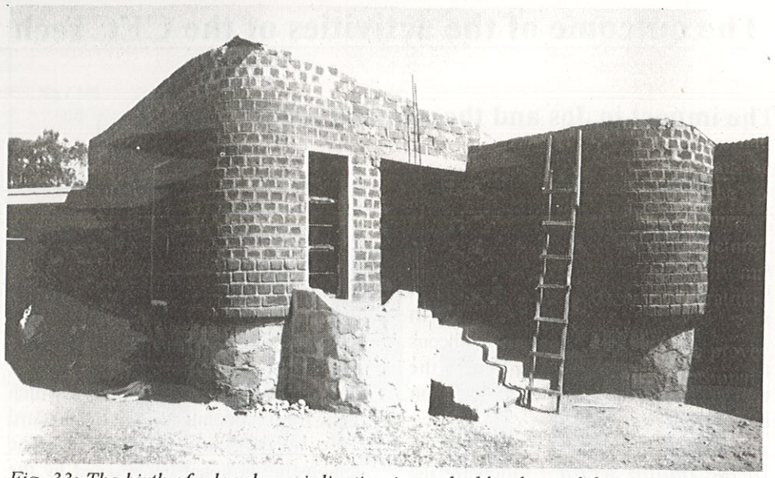

Fig. 33: The birth of a local specialisation is marked by the proliferation of sites

The impact of the activities of the Center on the nation can be measured by the number of visitors it hosts who have been on the increase since its inception. This number attained about a thousand persons in 1993. Half of this number came from areas other than Plateau State.

Applications for participation in training sessions organised by the Center are numerous and varied and presently come from almost all parts of the country and from governmental organisations, universities, companies. They confirm the growing reputation of the Center of Jos.

In the public sector : The construction of an Art & Cultural Centre in Abuja, Federal Capital Territory has been commissionned by the Abuja Council for Arts and Culture. The total sum of the project is about 1/2 million French Frances. The site would have been opened by the end of the year 1993.

Other states in Nigeria have started similar operations. Consequently, decision makers from Taraba State visited the Center in Jos and requested for advice to build a set of 100 houses in Jalingo. Their construction will be done by the Paris-West Nigeria Company Ltd. whose workers have been trained by the Center. The Ministry of Works and Housing of Kebbi State which registered two of its technicians for training is considering the construction of housing units for civil servants.

In the private sector: Several Nigerian companies based in Lagos and in other regions have imported production equipment including semi-automatic earth brick presses. In Lagos, a company "Bolyn" has manufactured and sold more than 250 small manual presses whose quality is similar to those manufactured in Jos. The totality of these presses, produced, sold and used in Nigeria, henceforth represents a production capacity of low-cost houses equivalent to about 4 500 housing units per year.

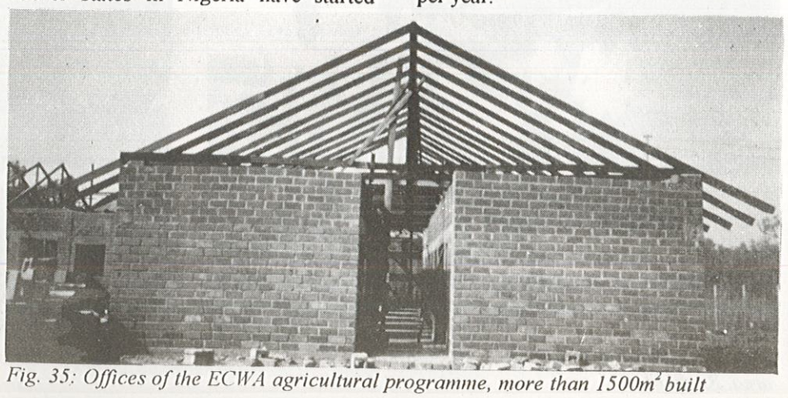

Fig. 35: Offices of the ECWA agricultural programme, more than 1500m² built

An Institutional and private network

Federal public institutions

National Commission for Museums and Monuments of Nigeria NCMM;
National Building Research Institute, NBRI
Federal Ministry of Science and Technology
Federal Directorate of Food, Road and Infrastructure
Federal Ministry of Works and Housing

Public Institutions of other States of the Federation :

Public Works Department, Abuja
Ministry of Works, Lands and Physical Planning, Ondo State ;
Ministry of Works, Housing and Transports, Taraba State
Ministry of Works, Lands and Physical Planning, Osun State
Housing Corporation, Kebbi State
Industrial Training Fund, Calabar
Industrial Training Fund, Jos

Public Institutions of Plateau State :

Ministry of Works and Housing
Bureau for Lands, Survey and Town Planning
Housing Corporation
Metropolitan Development Board, Jos
National Directorate of Employment, Jos
Raw Materials Research and Development Council, Jos
Engineers of the Rukuba Military Cantonment, Jos
Works Department of the Bokkos Local government

Universities and technical institutions :

Department of construction of Ahmadu Bello University, Zaria
Department of Architecture of Ahmadu Bello University, Zaria
Department of Architecture of Yaba College of Technology
Department of Architecture of the University of Jos
Civil Engineering Department of Plateau State Polytechnic Barkin-Ladi
Vocational and Apprentice Training, Jos
Department of Architecture of Obafemi Awolowo University, Ile-Ife
Department of Architecture of University of Nigeria, Enugu ;
Department of Architecture of the Federal University of Technology, Akure, Ondo State
Department of Civil Engineering, Kaduna Polytechnic
Department of Architecture of Bauchi Polytechnic
Physical Planning Unit, Bauchi
Government Technical College, Bukuru

Private sector of companies, building professionals and Government Organisations

Dazoutele Nigéria Ltd., Jos
Lunar-Sol Contractors, Jos
Laurel Corporation Nigeria Ltd., Jos
Kelson Konsult, Jos
Sam Barns and Partners, Jos
African Center for Development and strategic Studies, ACDESS, Ijebu-Ode
Plateau Investment Property Development, Jos
Construction Paris-Ouest Nigeria Ltd., Jos
Goddeyson and Company, Jos
Dream Homes Ltd., Jos
Consus Nigeria Ltd., Jos
Jimoh and Partners, Jos
Group Development Consultant, Jos
Evangelist Church of West Africa, Bukuru
Enugu Home ownership Corporation Ltd., Enugu
Imani and Sons Nigeria Ltd., Kaduna
Ink and Partners, Lagos
Modespro Nigeria Ltd., Lagos
Defeco Associates, Jos
Pekol Associates, Jos

In Lagos, the "Total-Consult" company has already completed several private residential projects. Equally in Lagos, Modespro Nig. Ltd. is considering launching several important building projects. The ACDESS, African Center for Development and Strategic Studies has started the construction of its offices and premises at Ijebu- Ode in Ogun State. In Kaduna State, the NEBC Training center constructs accommodation for students. A request has recently been made by a builder/promoter in Lagos for an architectural design and technical assistance; it involves the building of 100 apartments.

Numerous projects are presently being studied or in the process of construction and many among them are managed by those who participated in the national courses on earth brick technology organised in Jos.

Development of a national network of capabilities

More than about a hundred participants of different professional status have been trained since the beginning of the project: decision makers in government, architects and engineers, heads and lecturers of departments of construction and architecture of universities, polytechnics and technical colleges, contractors and technicians in construction.

These participants in training activities serve as instruments in the circulation of knowledge of this technology by starting sensitization and promotional activities themselves, by envisaging lectures and motivating or undertaking projects. This network of professional capabilities which is in the process of being structured comprises of federal institutions, institutions from different states of the Federation, universities, companies and professionals from the private sector.

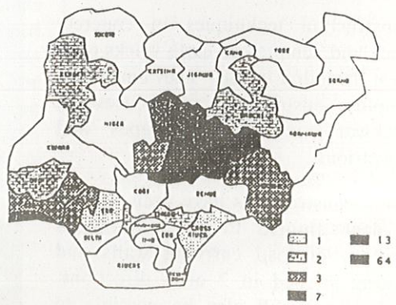

Fig. 36: Geographical distribution of 111 participants at the courses organised by CECTech, Jos

The emergence of a modern earth architecture

Aspirations to modernity by the local populace as well as architectural methods in vogue in Nigeria have been reference points in the construction of the most recent buildings. This was especially the case of the Centre for French Teaching and Documentation and of the 4-room model house built by the Center in 1992. From then on, it became apparent that earth architecture was capable of giving rise to modern constructions which can break the resistance linked to an archaic vision of the material used.

The constructing and architectural quality as well as the encouraging economic results of the initial constructions have motivated the interest and passion of professionals and of the population at the local and regional levels. Henceforth, these buildings are being associated with other constructions managed by regional and local building professionals who now register their technicians for professional training organised by the Center. Majority of these operations receive technical assistance from the center. This dynamism in the construction of houses has increased with a growing number of operations within the urban perimeter of Jos extending to Plateau State and other states of the Federation (Abuja, Taraba, Kebbi, Oyo, ...). They have been gradually won over by this modern, constructing and architectural use of earth material which is equally used in the construction of public buildings.

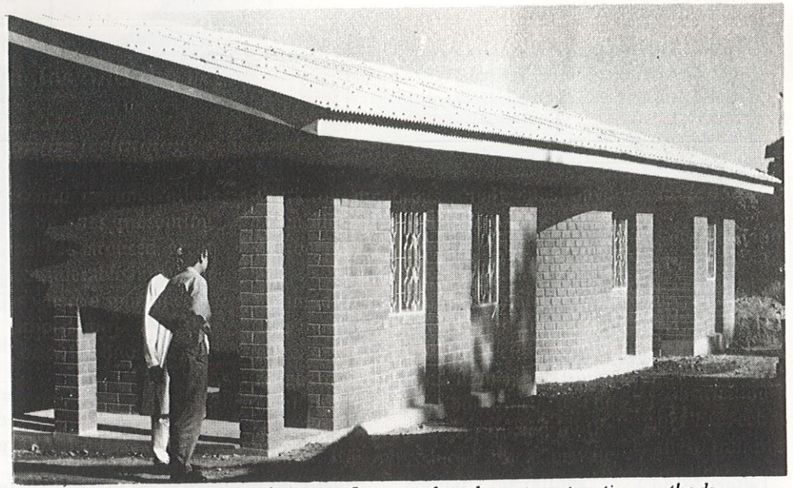

Fig. 37: The demonstration house in Jos introduced new construction methods

Fig. 38: ***House built by Moyet Company , Jos***

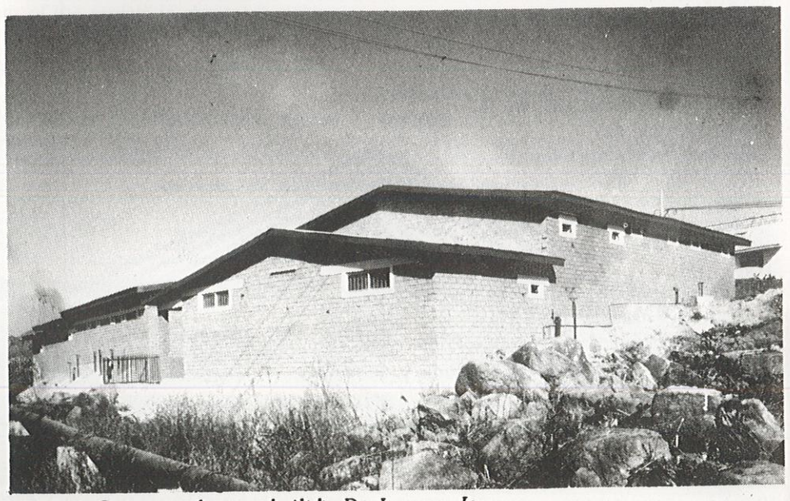

Fig. 39: Commercial centre built by Dr. Lawson, Jos

Arguments in favor of an appropriation of the technology

Flexibility of use

Construction techniques in concrete block and compressed earth bricks offer great flexibility in use. They enable the simple construction of houses in brickwork in various shapes and dimensions.

Initial constructions have been, for the moment, limited to an architectural typology of load carrying walls and roofing pitched in 2 or 4 directions. However, it will also be possible to introduce and develop typologies with load carrying walls and flat roofs, especially in the Northern regions with their semi-desert climate.

Grounds : a part of the vast grounds of the Nigerian Traditional Architectural Museum is made available to the Center for practical training and experimentation activities.

Assistance from the Cultural, Scientific and Cooperation Service of the French Embassy which is concretised by :

- the permanent posting of an architect to Jos, and the organisation of several field missions by experts from CRATerre-EAG every year;
- scholarships to France for staff employed at the center as well as allowances for Nigerian trainees who attend the training sessions in Jos;
- educational material prepared by consultant experts ;
- technical documentation, books and reviews which make up the basis of the documentation center of CECTech (300 reference documents).
- provision of a complete laboratory equipment for earth analysis; office equipment (computer and photocopier) and production equipment (presses) used for teaching, construction of buildings and demonstration.

Services

The CECTech of Jos offers a range of services which, through their simultaneous development, contribute to the promotion-development-distribution of modern earth construction technology, the training of professional abilities and the construction of demonstration sites which accentuate the constructive, architectural and economic potentialities of the earth material.

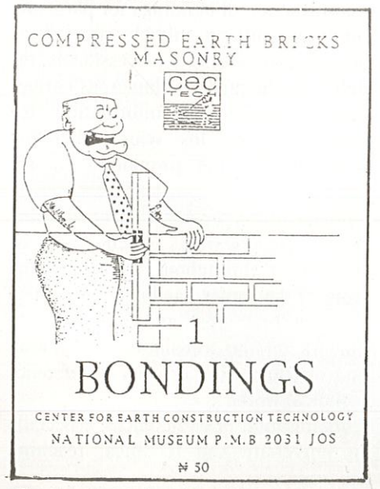

Fig. 26: 1st technical publication of CECTech

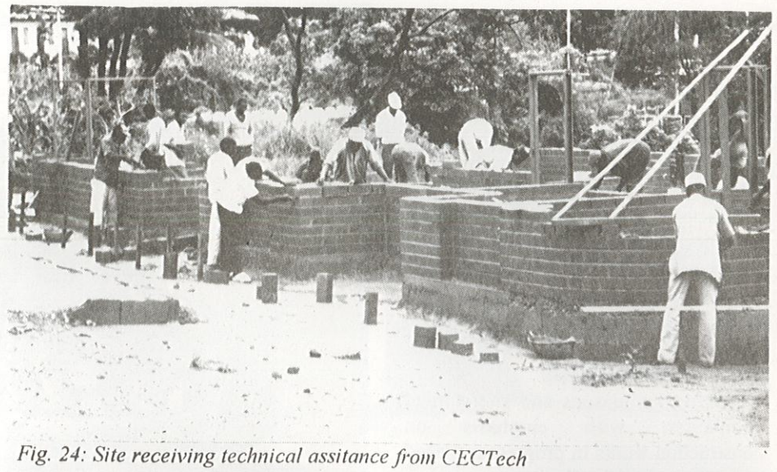

Fig. 24: Site receiving technical assitance from CECTech

Fig. 25: Practical courses organised by CECTech during the 2nd intensive course for site heads

Information:

An information service is accessible to the public on all weekdays. They comprise of :

- a center for technical documentation having at its disposal books, periodic articles, reviews, brochures and information leaflets on production equipment and materials. This documentary base was gradually formed in the last five years and presently boasts of 400 reference documents. The documentation center has recorded an increasing consultation from professionals, teachers and students as well as from the regional and local populace.
- an advisory service, offered free of charge by architects and engineers of the center, covers general information on construction, architecture, and production of materials. A growing number of professionals consult this service.

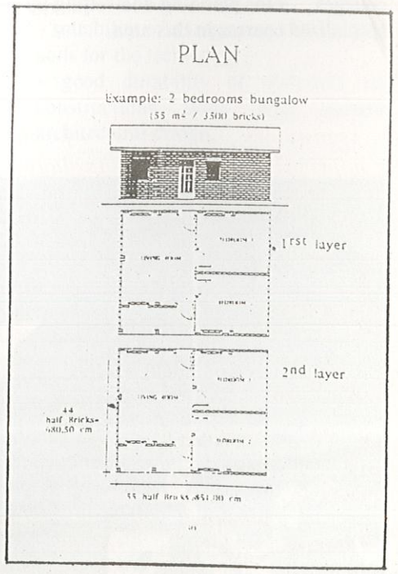

Fig. 27: 1st technical publication of CECTech p. 30

Training :

Training is one of the main activities of the Center and offers a package for different levels :

- training for architects, engineers and contractors which are paid for and which are designed to meet to national requirements ;
- training for site managers and work clerks which are also paid for, which respond to local, national and even national demands ;
- training for masons and site staff of companies, with emphasis on construction works in progress managed or supervised by the Center.

Fig. 28: Assistance in the production of compressed earth bricks, Bukuru

In order to implement this professional training activity, the CECTech has at its disposal educational material (course structure, practical exercise workbooks, graphical illustrations on projectable transparencies, slides) which were prepared by the consulting French team.

This training section has recorded a growing number of applications. Today, assistance in educational activity has been envisaged for other academic and professional training institutions (departments of architecture and construction of universities technical colleges, ...) for planning and setting up specialized courses in this area.

Technical Assistance :

The Center has a highly equipped soil analysis laboratory and an architectural design and technical studies bureau. The team provides technical assistance services to local and regional professionals. This activity is negotiated according to demand, or on the basis of each case presented, and has the following objectives .

- selection and analysis of soils for construction ;
- setting up small compressed earth brick production units (brickyards) ;
- assistance in the mastery of the architectural design ;
- mastery of work on design and completion of projects ;
- assistance in the supervision of building sites :

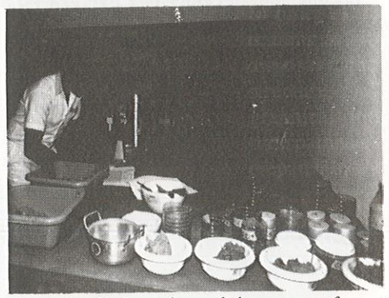

Fig. 29: Soil analysis, laboratory of CECTech

Fig. 30: Pavillon of the National Commission for Museums and Monuments of Nigeria at the Kaduna International Trade Fair of March 1992; price for Best Exhibition

Promotion and divulgence of the technology :

The range of promotional activities include:

- construction of buildings for particular purposes built on suitable sites which allow a wide access to professionals, the public or the media. Numerous curious visitors searching for information visit these sites in Jos which therefore contribute to the promotion of the technology ;
- production of technical documents and publishable works which can be distributed throughout Nigeria. The team of the center has begun to publish its own brochures and is hoping to embark on the translation, adaptation and distribution of articles or reference technical works ;
- organisation of conferences, especially in university and technical teaching environments;
- participation in national and international symposia.

Developed Materials and technology

The two types of material that have been considered for modern development in Nigeria are the adobe (or molded block) and compressed earth brick.

The adobe

The adobe is a material that has been very widely used in Nigeria for many years now. The parallelepiped moulded block has replaced the pear-shaped crude brick or "tubali" (Hausa word from Northern Nigeria) during the last ten years. The adobe is mainly used in rural areas but also in the periphery of urban zones which has a heritage of earth architecture constructed with this material in their old quarters. The production of adobes is simple- a brick molded in a simple wooden box, then dried in the sun.

The main advantages of the adobe are:
- no expenditure in the area of production equipment;
- simplicity of fabrication and use;
- national know-how and good knowledge of the technique;
- large range of soils can be used;
- very low cost of production, especially in rural areas;
- good durability of material and buildings if the design and treatment of details are adapted to the material.

The main disadvantages are:
- material is not valued socially since it is considered to be traditional;
- large quantities of water are used in construction for purposes of molding and a large surface area is also required for drying;
- the need for good protection of walls in humid climate areas;

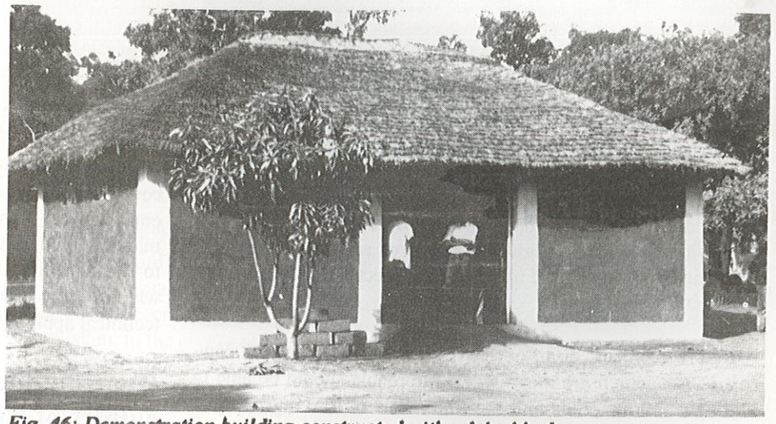

Fig. 46: Demonstration building constructed with adobe blocks

- building is not durable if its architectural design is not adapted;
- need for improvement of traditional, constructing and architectural details which are usually deficient.

Nevertheless, the adobe will certainly still remain one of the most popular materials for low-cost housing. Indeed, studies carried out on constructions using adobe in the Jos area show that improvements are possible, both for the purpose of rehabilitating the heritage and for modern construction and will remain one of the best alternatives for the construction of economical houses and even public buildings, particularly in rural areas. Constructions done recently by the National Commission of Museums and Monuments, as well as the Bauchi Museum proved this further. An experimental building was erected in Jos, within the framework of activities of the "Earth Architecture in Nigeria" project which confirmed the economic architectural potential of this material.

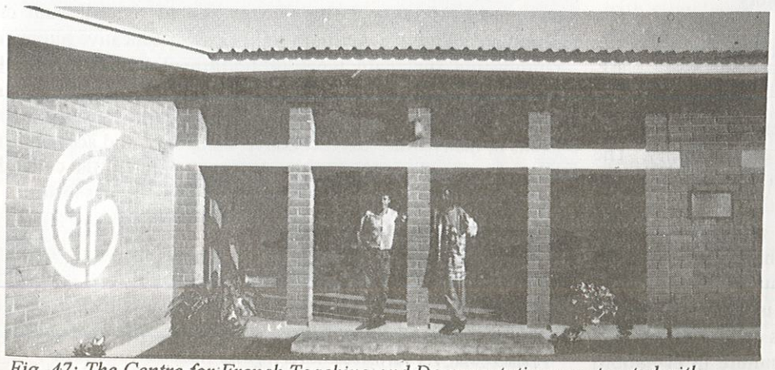

Fig. 47: The Centre for French Teaching and Documentation constructed with compressed earth bricks by CECTech, Jos

The compressed earth brick

The compressed earth brick is a new technology in Nigeria which was introduced in Jos and in the area of Plateau State by this project. It is a brick made from compressed soil in a press. The production of this material generally involves a stabilisation process, most often with cement (in a low quantity of 4 to 9%), which makes the soil impermeable to water and improves its resistance to erosion and compression.

The main advantages of earth brick are:
- socially, a worthwhile material (solid block which resembles the burnt brick);
- simple fabrication and use;
- suitability of a large range of available soils for the technology;
- good durability of materials and constructions done with suitable architectural design.

The major disadvantages are:
- limited knowledge of the technology in Nigeria till this day;
- huge investment in production equipment.

It is on this compressed earth brick technology, which was particularly well received by the professional construction environment, that efforts have been invested within the framework of the activities of the project.

The structuring role of the research activity

The development of a research activity has been a main preoccupation right from the inception of the programme. It became apparent, from an identification of the huge potentials of possibilities offered by the country on the question of "traditions and modernity of earth architecture in Nigeria", that studies and research works would highlight points of reaction and results necessary to structure and nourish the project on the question of low-cost housing.

Indeed, the pursuit of an objective of the development of low-cost houses which are most widely affordable should be able to highlight the materials and the know-how of a living national architectural and constructive culture in which the soil plays a primary role. This culture has fulfilled its role for centuries now in meeting housing needs and still proves, through accounts, its great potential of adaptation to physical, social, cultural and economic conditions of the environment. However, recent eras have witnessed partial or sometimes radical developments and transformations of this culture which could be associated to the rapid introduction of international styles of materials and technologies. It has become obvious, in the area of economic housing, that importation has introduced technical and architectural methods that are very often unsuitable and too expensive particularly in the present economic situation of the country. Therefore, the hypothesis and perspectives of investigation are formulated on the observation of the development of traditions towards new constructive and architectural models, and introducing a new housing heritage that is affordable to the majority of the population, both in rural and urban areas.

Furthermore, the quality and durability of new houses capable of highlighting this potential must be guaranteed. For this purpose, a scientific approach alone through research works will bring about the necessary technical improvements. The materials and local practices have to be studied in order to better identify their good qualities, deficiencies and be better placed, therefore, to specify which improvements could be introduced bearing in mind that no solution would or could be generalised. A regional definition of the territorial, cultural, social, technical and economic area of investigation is obligatory

Two main research angles have been identified and led to the introduction of programmes from May 1991.

- A first research angle deals with the general knowledge of constructive and architectural earth culture of the country. The programme which was formed covers, on the one hand, the general discovery of this culture in the whole country (emphasizing successive study travels and investigation of the bibliographic base) and on the other hand, the in-depth knowledge of a more specific regional culture, in this case, Plateau State, from and around Jos which is the action base of the project. A programme of investigations on the heritage and modern earth construction (constructive culture in evolution) has been launched in this Plateau area.

- A second research angle is linked more directly to the scientific and technical follow-up of the development of the earth construction technology. The programme which was launched covers the analysis and the choice of laterite soils to be used in construction, the performance evaluation of locally manufactured earth brick presses, on-site quality control linked to the objective of the establishment of technical documents which will be used as working tools by operators, and finally, a technical approach of the pathology of materials and works.

Knowing the constructive and architectural culture of Nigeria

What is known about the architectural heritage

The National Commission for Museums and Monuments of Nigeria (NCMM), which was inaugurated in 1979 succeeded the Federal Department of Antiquities, (FDA). It is responsible for the administration of national museums , antiquities and monuments, the creation and maintenance of museums and other connected materials. By the time the NCMM was created and took up its responsibilities, the Federal Department of Antiquities had already accomplished an enormous work on inventory and study of the monumental, architectural heritage and traditional houses. This work, covering the whole of the country, was managed and pioneered by Professor Zbigniew Dmochowsky with teams from the FDA and the Commission, for more than 20 years. This work was recently published by the NCMM in three volumes and is a good reference for this kind of work on the African and even international levels and states all that is known on the traditional heritage[1].

Simultaneously, the main national museums (that of Jos in Plateau State is the first of its kind) were created by the Federal Department of Antiquities and since then, the National Commission of Museums and Monuments has continued this important and essential work. It draws up a list of 500 buildings and sites, out of which are 61 monuments (18 of them have since been declared national monuments) and is actively involved in restoring, and even reconstructing those of them that are more threatened. It started the construction of the Museum of Traditional Nigerian Architecture in Jos, an educative museum reproducing the main types of traditional architecture and monuments of the country on a large scale and a vast terrain (this project was not concluded owing to lack of funds). The teams of the NCMM are very active, competent and accomplish a lot of work whose objective is the preservation of the cultural heritage of the country and its development in various forms.

1 Dmochowski, Z., "An Introduction to Nigerian Traditional Architecture", Vol. I : Northern Nigeria, Vol II: South-West and Central Nigeria, Vol. III: Eastern Nigeria, Ed. Etnographica and NCMM, London/Lagos, 1990.

The great regional diversity of the earth architectural heritage

Generally, and following the territorial classification established in the work directed by Professor Zbigniew Dmochowsky, three main patrimony areas : the states of Northern Nigeria, the East and South-East and the South West have been defined.

The Northern states

The ***Hausas*** are a linguistic group comprising of more than 40% of the population of the Northern region. They are mainly concentrated in the Kano, Sokoto, Katsina, Zaria, Bauchi and Niger provinces. Their earth architecture which had been developed for many years before the introduction of Islam, in the 13th century - and which spread as time went on up until the era of the famous "Bakwai" of the great City-states and the emirates of the North whose stylistic apogee was attained during the XVIIIth century - is mainly constructed in pear-shaped, conical clay brick locally called "tubalis" It is a rectangular shaped architecture with sturdy, thick walls, tapering towards the top and consolidated by buttresses. The flat or dome roofs are carried by earthen arcs reinforced with azara wood, column chapiters in brackets, or by sheets of small pieces of the same azara wood, in successive projectures. This is a mixed technique which is today unique in the world. The big towns of the North

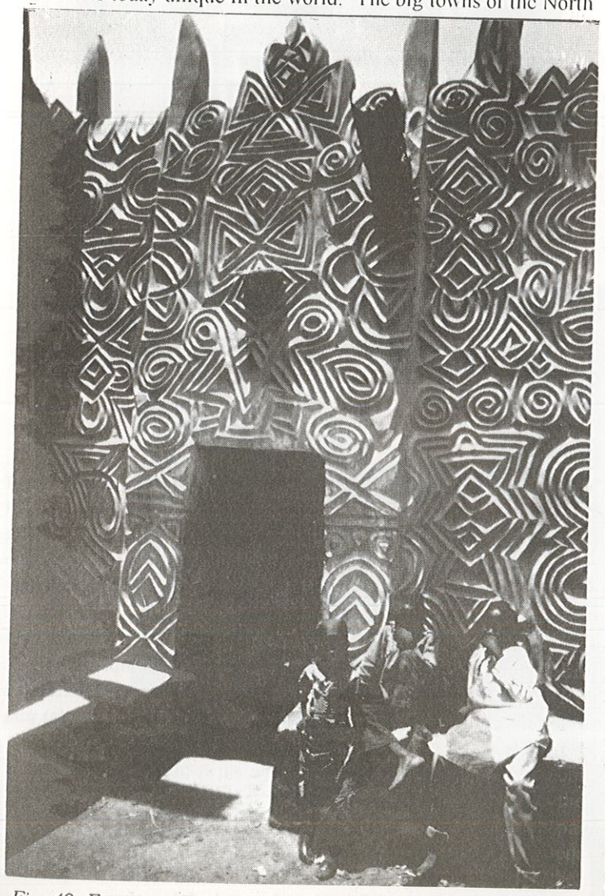

Fig. 48: Entrance (Zaure) of a house in the ancient town of Zaria

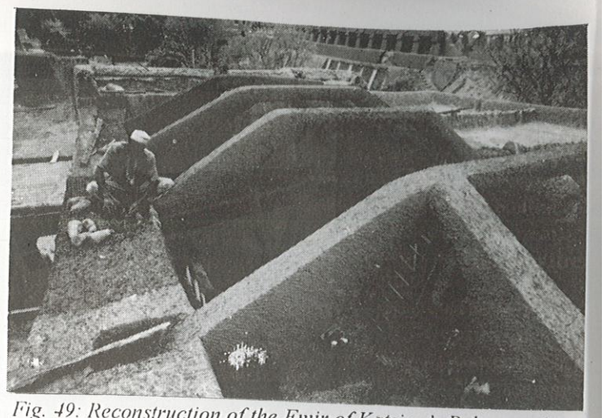

Fig. 49: Reconstruction of the Emir of Katsina's Palace at the Jos Musuem. Heritage preserved from technique of building an earth arc reinforced with azara wood.

such as Zaria, Daura, Katsina, Kano provide the most beautiful examples with their oldest mosques (Zaria), their Emir's palaces (Daura, Katsina, Zaria) and more recent buildings (e.g. Old Teaching College, Katsina, opened in 1921).

The ***Kanuris***, mainly found in the Chad Bassin in the North East are the heirs of the ancient kingdom of Kanem-Bornu. Their architecture comprises of curvilinear buildings, vast huts with massive earth and straw walls covered with thatch which accommodate the family unit under one roof. Further North, the ***Madans*** are a nomadic race who live in seasonal reed houses woven with great skill in form of a reed overturned basket. The people of Plateau State form an important group and comprise of a large number of small ethnic groups. Apart from the towns, the traditional architecture of this region which is in a Savannah and rocky (inselberg) landscape, is most usually of a defensive nature, round shaped, with walls shaped from clayey soil and straw inlaid with gravel like that of the ***Rukuba*** people. The organisation of the home, in small hut groupings enclosed by a protective peripheral wall is ideal for a communal way of life. In the towns, earth architecture in rectangular shaped earth clay bricks and sheet metal roofs have replaced the traditional thatch. Among the other dominating groups, the ***Nupes*** who occupy territories situated at the North of the Niger and West of its confluence with the Benue, have an architecture of soil mixed with straw, with massive walls and thatch roofs, having both curvilnear and rectilinear shape. The palace reception of the Etsu Emir of Pategi called "Katamba", reproduced at the MOTNA of Jos is designed to link two concentric circles. The interior has a massive earth wall of 45 cm thickness, the exterior which is demarcated by a verandah, has admirably sculpted wood columns supporting the roof. Finally, the ***Tiv*** people, concentrated in a small territory at the South of the Benue, have designed an architecture of round huts which increase along with the extension of the family unit, organised however, around a central reception roof called the Ate. It is a vast roof erected on a double concentric plan and carried by peripheral wooden poles while the internal circular wall is a non-load carrying cambered crest wall which serves to protect against splashing of water at the same time providing shade from sunlight and maintaining coolness.

Fig. 50: Set of Nupe style houses, Jos Museum

The Eastern and South-Eastern states

These regions which are covered by a dense forest have been rather favorable to the emergence of decentralized human establishments in small villages accommodating extended family units or several families of the same kin. The ***Igbo*** people are made up of small hereditary kingdoms comprising several villages but also, very many clans boasting of larger groups or of a common ancestry (e.g. the ***Ngwas***). The ***Ibibios*** have a social structure similar to that of the Igbos and are in a situation of territorial proximity. Such is not the case of the ***Efiks*** (Calabar area), who are geographically close to the Ibibios but very different from them.

The earth architecture of the Igbos (in wallow or timber framework and daub) is very remarkable, with family units closed at the exterior and organised around an internal patio which plays an impluvium role. The rooms for men and women are separated while the children occupy a single room and these are designed at the back on the passage which runs around the building by earth platforms protected on both sides by the overhanging thatch roof carried by wooden poles. The entrance of the house is generally designed in a way to produce a facade of a monumental appearance with a massive earth colonnade forming an atrophied peristyle reduced to this single facade.

Fig. 51: Full view of the Mbari Temple, Igbo architecture, Jos Museum

The central access leads directly into the patio below. The rear of the house opens into a common courtyard generally limited by a fence wall which has a space for an exit. These houses which preserve the intimacy of each family are most usually united in urban type establishments at the centre of which the Igbo community builds meeting houses, age group houses and erects cult altars and statuary.

The South West and Western states

Four main groups of the Nigerian population live on the territory situated at the South and the West of the Niger: the ***Yorubas***, the ***Edos***, the ***Ikas*** (Igbo sub-group) and the ***Ijaws*** (or ***Izans***) of the Delta.

Fig. 52: Inside Ilorin mosque, Jos Museum. Earthen arc reinforced with wood.

The vast Yoruba territory, still centered on the famous town of Ile-Ife, guards a geographical and cultural unity inherited from the ancient structure of a great kingdom founded on a strong group conscience in spite of numerous dialectal variations. The large scale political organisation of this territory, hitherto led by the Alaafin of Oyo and his counsel establishing laws for the kingdom, led to a high degree of urbanisation. The traditional structure of houses and palaces of dignitaries comprises of vast units, regrouping in common ownership, several extended family units (degree of relationship attaining thirty levels) and friends. The communal way of life is therefore predominant. The buildings are done in massive earth and the structures of columns and beams are made with sculpted wood carrying heavy and steep roofs which cover the buildings organised in a courtyard and impluvia system. This system is similar to regular houses as well as palace architecture, the difference being in the size, one is a replica of a reduced model of the other.

The Yoruba palace, residence of the kings was the most impressive building of the towns of these western regions of Nigeria. Encircled by a high wall, inside a fortified town, it occupies a large surface area due to its multiple family units owned communally which are constructed around intercommuniquable courtyards. It also included all communal infrastructure such as a crafts and commercial section, the town assembly, the court of justice and sometimes, a theatre. The splendour of these palaces reflected the importance of the sovereign or dignitary. These vast units were maintained by the people of the town and villages who owed allegiance to the king. They were constructed in earth, generally in wallow and, depending on their size, could be erected as two-storey buildings with wooden floors. The roofs were generally thatched.

The ***Edo*** people occupy the territories of the ancient kingdom of Benin which became very prosperous and powerful up to the era of the Portuguese colonisation in the XVth century. They discovered a political unit which, to them, was the most structured of the whole of the Guinea coast (Gold Coast), which included Lagos and a range of sub-groups up to the eastern territories of the Igbos. The beninois architecture of the Edos is similar to that of the Yorubas as regards the organisation in common family units around the court. The walls, erected in wallow (soil stabilised with palm oil), are generally blind from the exterior facade. Openings are rather found on patios, altars with open ceiling and courts fenced by massive colonnade systems. Rain and domestic water are cleared very effectively through a very sophisticated drainage system with canals covered with stone slabs and directed towards the exterior. The very red soil used and the horizontal, ribbed shape (maintains a permanent shade) of the facing of the walls, very typical of this beninois architecture, gives it an austere as well as very organic aesthetic value (e.g. house of Chief Ogiamen in Benin). The roofs are thatched with palm leaves erected on a very elaborate wooden and bamboo or raffia rib framework and provides a ventilation system in low verge on the slopes and at the higher section. The interior decoration of these beninois palaces highlight bronze and ivory craftsmanship which are very typical to this culture and of a remarkable quality.

The ***Ika Igbo*** people found on a small area situated between the Edo territory and the river Niger, paid allegiance to the Benin kingdom. They obtained their autonomy in the era of the British administration in order to get closer to the Igbos. Their earth architecture is similar to that of Benin, as regards style and the structure of the designs. However, it is on a smaller scale and does not use the ribbing or massive column aesthetique methods. The courts and impulvia are generally encircled by verandahs which precede the living rooms.

Finally, the regions of the South of Nigeria on the coastal territories of the ocean and in the great delta of the Niger, around creeks and lagoons where swampy or mangrove soils are found, have been inhabited for a long time now by people who live traditionally on fishing and agriculture. The ***Ijaws*** (or ***Izan***), the ***Kalabaris***, live in a lighter housing architecture, of a simple rectilinear shape, made of wood and plants (raffia, palms) and most usually erected on pile work except on few pieces of land spared of water.

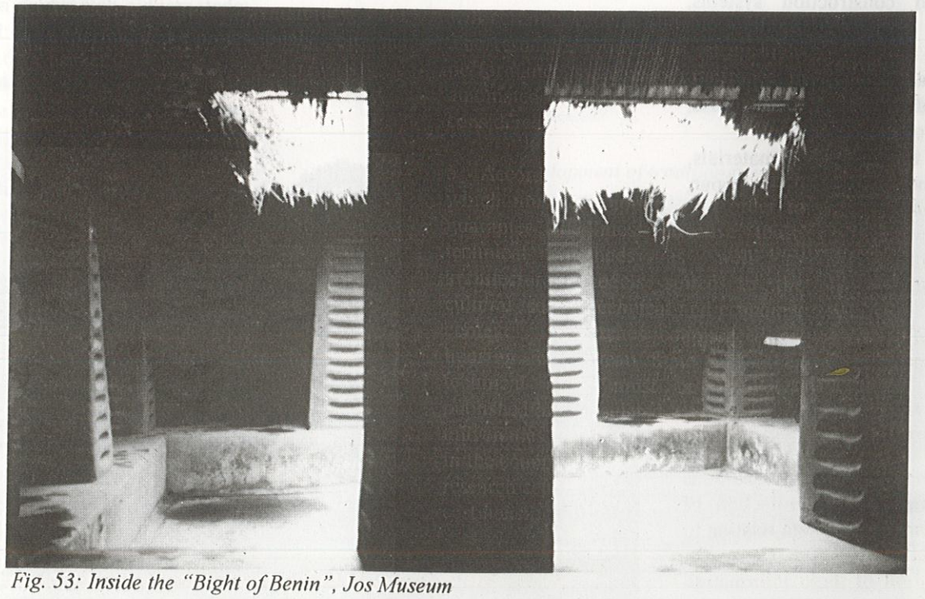

Fig. 53: Inside the "Bight of Benin", Jos Museum

Earth Construction in Plateau State

Beyond a general review of the earth construction and architectural culture of Nigeria confirming the diversity and the richness of its potential, a decision was taken to develop a specific research on Plateau State. This choice is justified by the necessity to limit the field of investigation which was too vast and to stick closely to the realities of the context of the development of the low-cost housing project launched from Jos.

Fig: 54· General view of a traditional Rukub village

Objectives, method and activities of the programme

The objective of this research carried out on Plateau State is to build up a data base which will allow a more precise evaluation of the potentials of the use of materials and know-how for application on modern housing projects in this same region. The expected results will lead to the elaboration of application strategies, technologies to be developed, organisational or work methods, construction and architectural solutions which will be more suited to the present economic, technical and socio-cultural context and adapted to the local know-how.

The research programme identifies four main areas of investigation:

1- study of regional, traditional and modern houses : construction materials, structure and construction systems, architectural details, durability and maintenance;
2- architectural culture : organisation of the private and public areas of the house, shape and perception of space;
3- economy: availability of materials, qualified and unqualified labour, organisation of work schedules, material and labor costs, investments, amortisations, accessibility ;
4 - organisation of the construction and maintenance practices : types of operators and know-how, methods of transfer of know-how, usage practice.

The research method is specific to three successive work stages:

1 - observations, summary presentations and discussion for the collection of specific information and data relating to different fields of investigation;
2 - classification of these information and data, and then analysis based on a technical, economic, social and cultural view point ;
3. - constitution of the data base highlighting the main characteristics of the objects studied.

Activities linked to this programme are:

1 - analysis of the existing documents : articles, books, ...
2 - Design of questionnaires for collecting information;
3 - Field investigations ;
4 - collection of samples of materials
5 - analysis of information gathered.

The area of investigation included some ancient and modern quarters of the town of Jos, a section of the constructive and architectural tradition of the Rukuba and Birom ethnic groups, a section of architecture of schools built in clay bricks by Christian missions at the end of the XIXth century and at the beginning of the XXth century, the housing architecture and the hospital scheme of the tin mining industrial area in Barakin Ladi. The work was done during the spare time from the mainstream of activities of the project but still helped in gathering much information, particularly in form of graphic and photographic data which are placed on an inventory list and then filed. A first phase of analysis of this earth construction culture of Plateau State has been commenced.

Fig. 55: Full view of a typically traditional Rukuba concession.

First analysis : a construction culture in transformation

In order to properly understand the construction culture of the popular and economic houses of the region, beyond the identification of the traditional construction and architectural typologies that are described in detail in the work produced by the NCMM in collaboration with Professor Dmochowsky, we needed to recognize and understand the stages of development and transformation linked to the introduction of new materials. construction and architectural models and methods of organisation of the work economy. The first observations of the analysis are the following:

In the rural area:

The typically traditional house is always organised in form of franchise composed of covered, independent and individual housing units, linked by fence walls demarcating the family unit space. At the center of concessions are lofts which by their reciprocal position with the different housing units determine air spaces (circulation, courtyards). The concessions vary in size depending on the size of the family.

The walls of this house are in worked soil but two main typologies relative to the method of roof construction can be distinguished. On the one hand, the dome in worked soil (Rukuba ethnic group) and on the other, the framework in small wood, usually fixed on a ceiling equally constructed in small wood and covered with soil (Birom ethnic group). In some cases, the two typologies of roofs coexist in the same concession.

The introduction of the clay brick, replacing worked soil or worked soil and stone, brought about a modification in the traditional typology. Round shapes lost their interest and became more vertical. Sharp angles were introduced with the appearance of rectangular shapes. Shaped woodwork integrated with earth masonry tends to disappear and regular door and windows have been introduced. On the transformed round shapes, the dome made from worked soil is usually replaced by a conical frame made in small pieces of wood.

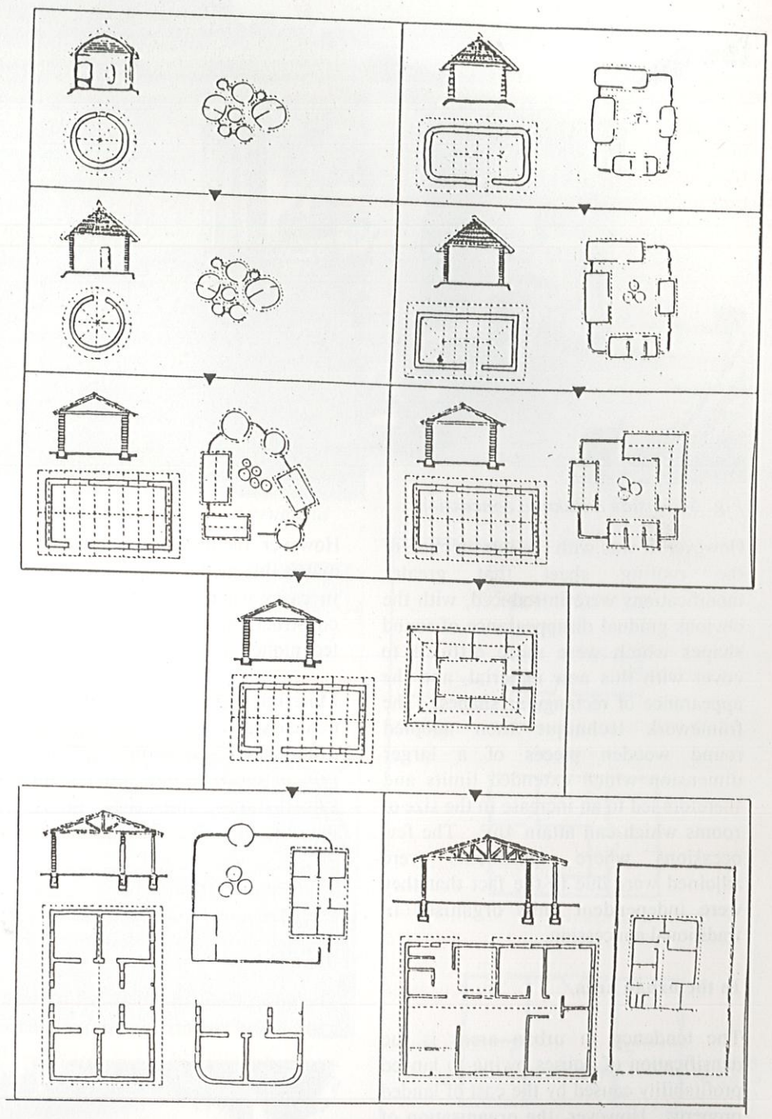

Fig. 56: Synthesis of the development of traditional housing models

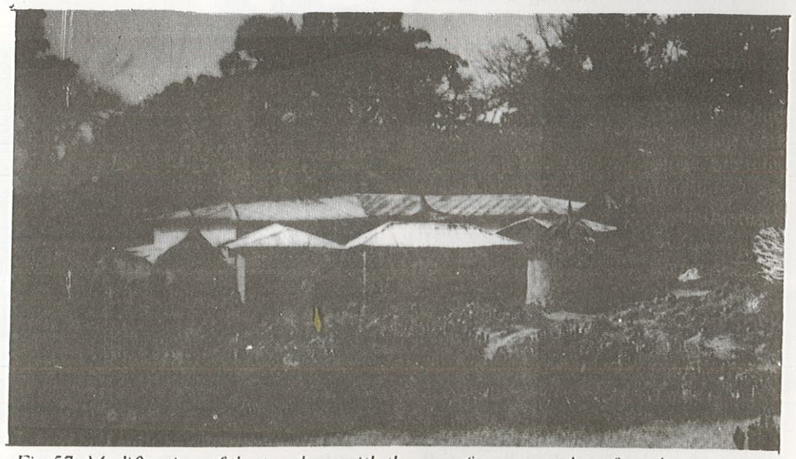

Fig.57: Modification of the typology with the use of corrugated roofing sheet

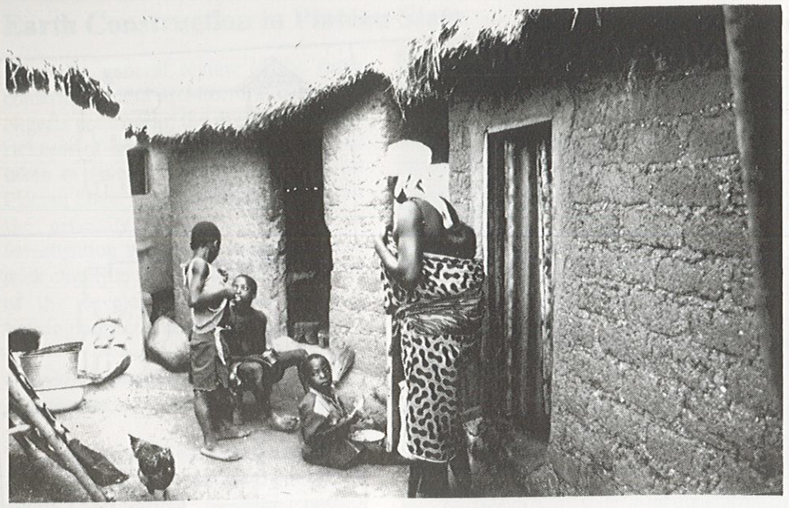

Fig: 58: Inside a Rukuba concession

However, it was with the introduction of the roofing sheet that greater modifications were introduced, with the obvious gradual disappearance of round shapes which were more difficult to cover with this new material, and the appearance of rectangular shapes. The framework technique then adopted round wooden pieces of a larger dimension which extended limits and therefore led to an increase in the size of rooms which can attain 4m². The few occasions where apartments were adjoined were due to the fact that they were independent units organised in traditional concession.

In the urban area

The tendency in urban areas is the densification of houses owing to landed profitability caused by the cost of landed property. However, the organisation of independent units sharing a common wall around a courtyard persists. Due to the reduced dimension of the courtyard, it is more like a patio. Storehouses tend to disappear and with them also, internal courtyards. This traditional house model is still a reference point, even for rented accommodation which, in Jos, abound since they are presently cheaper and therefore more affordable to a greater majority of the people.

A reference model however, still remains the dream of many families. This model is that of a "block-house" with a false ceiling and all the rooms having the basic electrical and sanitary amenities. This house is imagined to be at the center of a plot fenced in by a wall.

However, the present economic situation makes this model hardly affordable even in cases where in the owner-managed construction, cheaper materials and techniques are used.

Materials evolve and the general tendency is to replace soil finishing with sand-cement finishing. The sand-cement block is only used mainly for substructures and very rarely, for masonry of walls. The development of materials relative to that of shape is especially remarkable as regards the frame which evolves in complexity due to more important improvements to be made. The use of sawn timber improves the construction and enables the fixing of a false ceiling. Recently, the shape of these urban houses have been likened to the method of urban architecture of more prestigious houses which have reintroduced rounding in place of sharp angles.

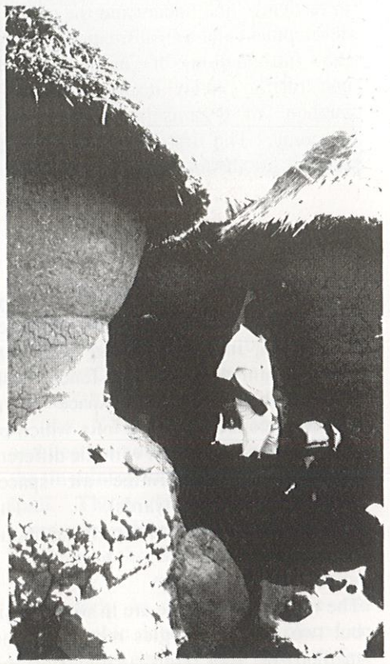

Fig. 59: Storehouse of a concession near Pankshin

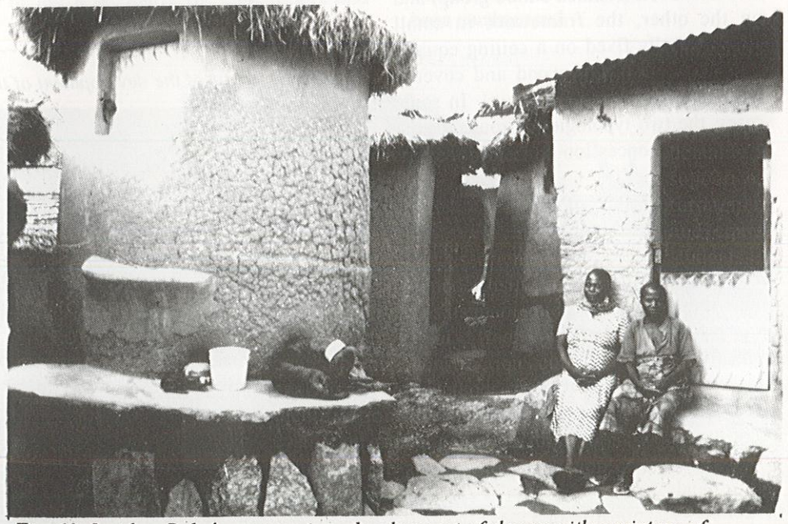

Fig. 60: Inside a Rukuba concession: development of shapes with a mixture of rectilinear and round typologies.

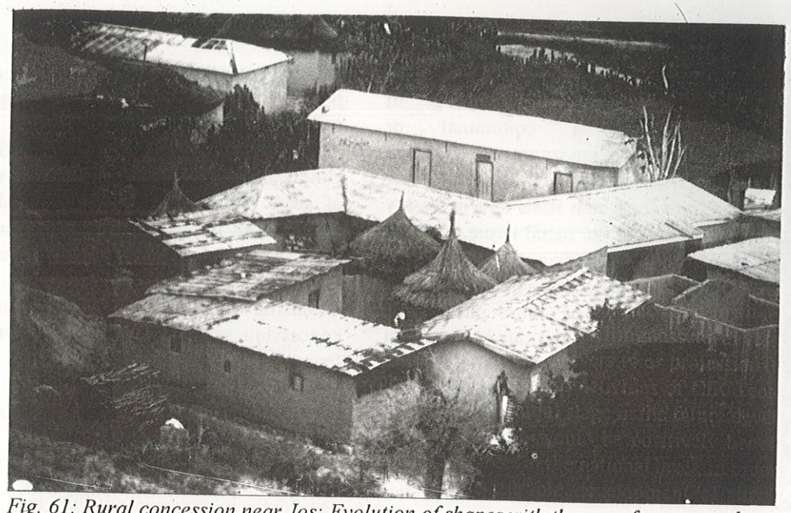

Fig. 61: Rural concession near Jos: Evolution of shapes with the use of corrugated roofing sheets. The traditional storehouses still remain.

Fig. 62: Construction of a shop at Barakin Ladi

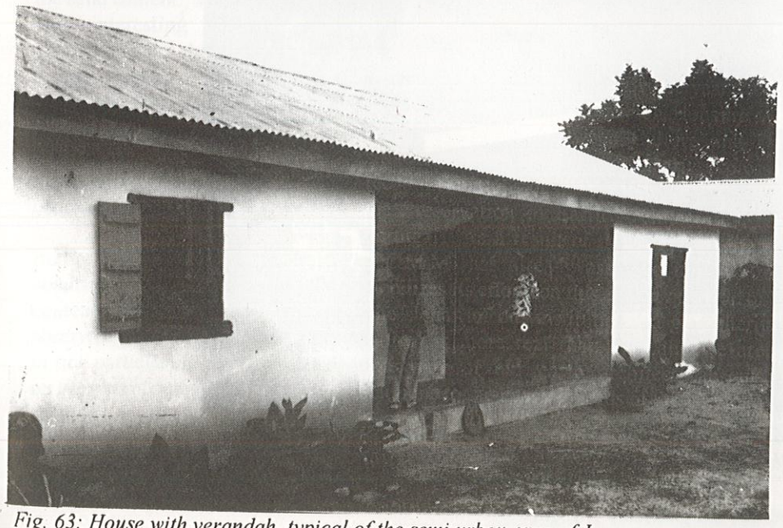

Fig. 63: House with verandah, typical of the semi urban area of Jos

In semi-urban areas

One observes, in the semi-urban areas, the development of a model of concessions which include a "block house" having mainly the living room and the rooms. The courtyard, which remains, contains the kitchen, the sanitary and bath units as well as the storehouse in an unchanged shape. This organisation in family concession takes its architectural and stylistic identity from an element that is becoming more and more constant - the verandah, generally situated at the entrance to the living room and performing the function of main entrance to the concession.

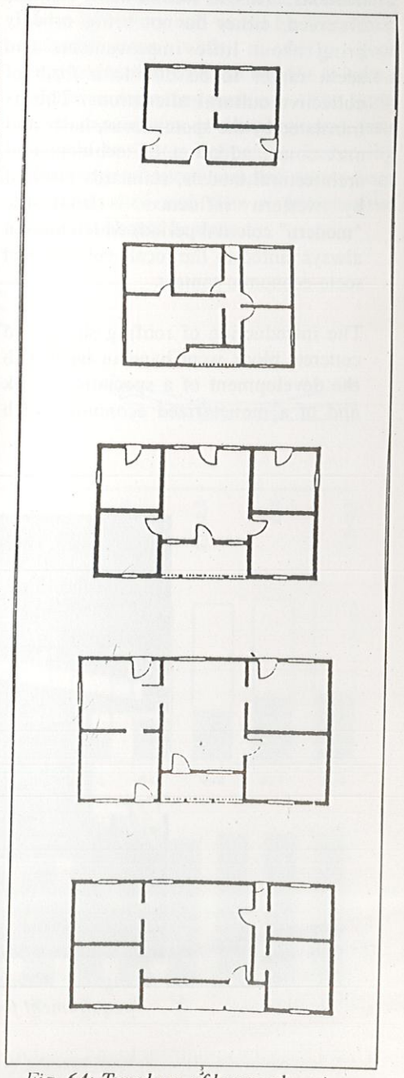

Fig. 64: Typology of house plans in semi-urban areas

The work plan

The evolution of materials, techniques, models of houses was accelerated during the economic period prior to the years of splendour (end of the 60's and beginning of the 70's) but it appears to have slowed down since then with the worsening of the economic crisis during the past ten years. This development nevertheless, has had a considerable repercussion on the affordability of decent accommodation to a great number of people. It appears obvious that the sort of reflection that is necessary to solve this problem of economic housing should include facts derived from the analysis of this evolution, its reasons, motivations, inspirations, types and dynamic methods. This, as well as many changes observed, either do not bring or only bring about little improvements and seem rather to be due to a form of collective cultural alienation. This is translated by the spontaneous, hasty and unreasoned adoption of technical and architectural models, standards inspired by western influence (from the "modern" colonial period) which are not always suited to the local, cultural and socio-economic context.

The introduction of roofing sheets and concrete block went hand in hand with the development of a specialised work and of a monetarized economy which substituted cultural, social and economic ancestral practices of exchange of services in a communal or neighbourhood environment. Though monetarization is a certain factor for development which leads to a necessary redefinition of the social tissue of trades and economic exchanges, it seems to have had only limited repercussions on the emergence of more affordable, decent, qualitative and durable low-cost houses. For instance, an observation was made from a visit paid to a concession in the "Rukuba" area where the head of the family had two huts - which is not traditional - one covered with thatch and the other with roofing sheets. The latter is very rarely used since, according to the head of the family, "it is too hot in there in the hot season and too cold in the cold season" and "it is too noisy and it is difficult to sleep" during the rainy season.

Apart from this question of comfort in the house and that of the cost of materials, on which majority of the reflections are based (research for a technological alternative), several observations appear to gear towards opening up other paths which deserve particular attention:
- construction of concessions in stages composed of independent units will reduce costs while the fragility of presently proposed finance systems is not really supported by most people;
- this system of concession ensures the closeness of independent units, and even of each of the different courtyards, especially at the exterior. Modification of these types of concessions in the future is always possible ;
- housing units built at the end of the concession saves the cost of building fence walls ;
- in the case of block-houses, privacy is usually reduced both inside the house and in the courtyard;
- finally, a lot of the traditional construction materials, though criticized for their lack of durability or heavy maintenance demands, are, in our opinion judged too strictly. They are still reliable alternatives. They use simple materials and techniques which can contribute to the emergence of inexpensive solutions and which can be improved. Investigations and experiments in this direction should be encouraged and supported.

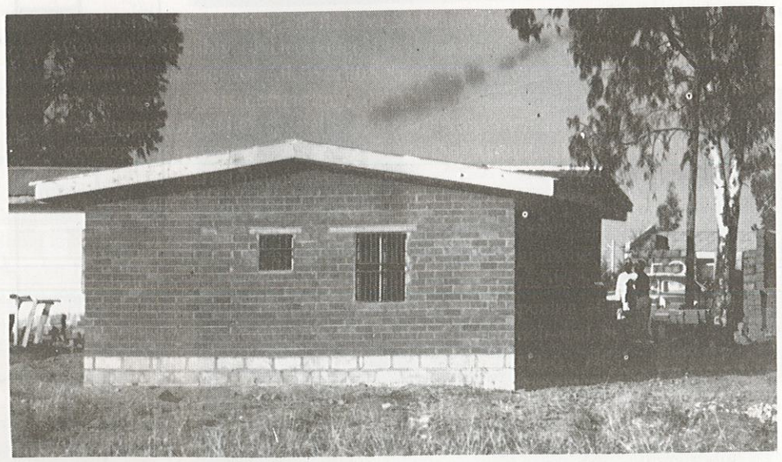

Fig. 65: A small-size low cost home meets a social need and is a compulsory requirement for the immediate future

Application of Research

There are four on-going programmes:
- choice of laterite
- performance of block presses manufactured locally ;
- quality control and technical recommendations ;
- pathology and preservation.

Choice of laterite

Considering the multiple small construction operations and the tendency towards autarky work of small contractors and site operators for whom the investment on soil analysis in a laboratory is too expensive, a research was carried out with the objective of establishing the proficiency of inexpensive ground tests and the establishment of a connection between the laboratory tests and the ground tests. This research path seemed to be pertinent due to the mainly lateritic nature of soils available in Nigeria which are relatively easy to identify. Three main tests were retained since they provided immediately interpretable results : cigar test (cohesion), bottle test (size grading by sedimentation) and measuring of dry density (mass density). The retreat test (Alcock test) was put aside temporarily since the response time is much longer.

The procedure adopted was the systematic comparison of the results of these ground tests with those done in the laboratory. However, in order to obtain faster results, mixtures of fine soil and sand were tested to measure the sensitivity of these tests to the sand content. The results proved to be very interesting because, as regards qualitative tests, the laboratory analysis of a large number of laterite samples taken in Plateau State, and even on other sites in the country showed a lot of similarities. Variations were only observed for quantitative tests. The first set of conclusions were the following:

Bottle test: very good results were obtained on the specification of the sand content measurement. Differences observed in the measurement of the height of fine particles in suspension, depending on the type of water used, did not give any reliable results. Consequently, the measurement tended towards a procedure where the height of dry soil is normalized and the sand height alone is measured.

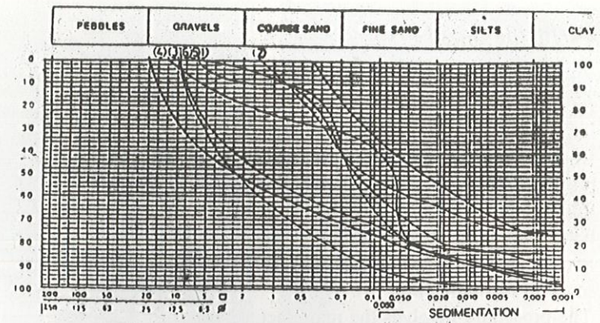

Fig. 66: Granulometric analysis of several soil types in Plateau State; many of them are suitable if used correctly

Cigar test: it also gives high-contrast results but not very reliable with extreme, low or high sand contents. Mixed, qualitative and quantitative results were obtained which should therefore be compared with the results of another test in order to obtain a correct interpretation. Measurement of density: measurement of fine particles and sand give very different results. It was confirmed that the density of laterite varies typically depending on the sand content whose measurement could be a good indicator. Nevertheless, a scale is required for this test.

The results of these tests all depended on a risk of inaccuracies in the different procedures (manual operation). Nevertheless, for most of the tested laterites, results from the ground tests were close to those that could be obtained in a laboratory and would facilitate their identification with a fairly good approximation so as to be able to take a decision regarding their use. The limits and capabilities of these ground tests should be better defined by increasing the range of tested samples, taken from various sites and then a comparative analysis should be done.

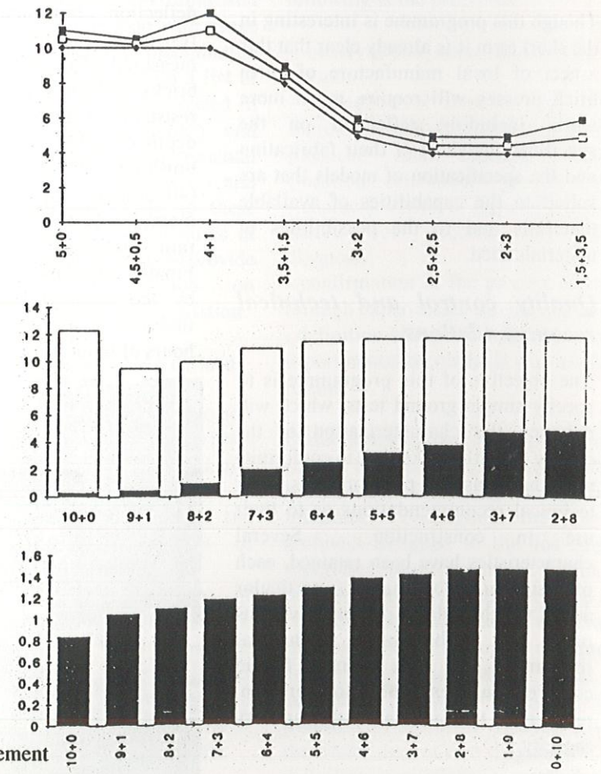

Fig. 67: Checking the validity of ground tests in order to recognize the quality of a soil sample by varying the fine particle/sand proportions

Performance of presses

The objective of this programme is to review the performance of locally manufactured earth brick presses, both from the point of view of their handiness, durability as well as their performance under compression with a view to a better definition of areas of improvement and to specify recommendations to be made to manufacturers.

The procedure involves the manufacture of a series of bricks and the observation of machines already used or in the process of being used. In the absence of a suitable material for measurement, performance under compression is measured by comparison with a standard press on the density at the lifting of the pattern (simultaneous measurement done on the same mix). Performance tests are also carried out on the bricks according to the procedure established by the quality control programme which will provide a better knowledge of the importance of compaction in relation to other factors influencing quality, particularly stabilization. A bigger programme carried out on many more machines is presently going on.

Though this programme is interesting in the short term it is already clear that this aspect of local manufacture of earth brick presses will require much more work, including reflection on the specifications sheet of their fabrication and the specification of models that are suited to the capabilities of available materials and to the possibilities of materials used.

Quality control and technical recommendations

The objective of this programme is to specify simple ground tests, which will enhance the characterization of the quality of earth bricks and, in conformity with the measured performances, offer technical recommendations as to their use in construction. Several characteristics have been retained, each of them corresponding to a particular aspect which could be proven on various parts of a building: mechanical resistance to dry and humid compression, resistance to abrasion, resistance to erosion and capillary capacity.

Simple tests were chosen to measure each of these characteristics.

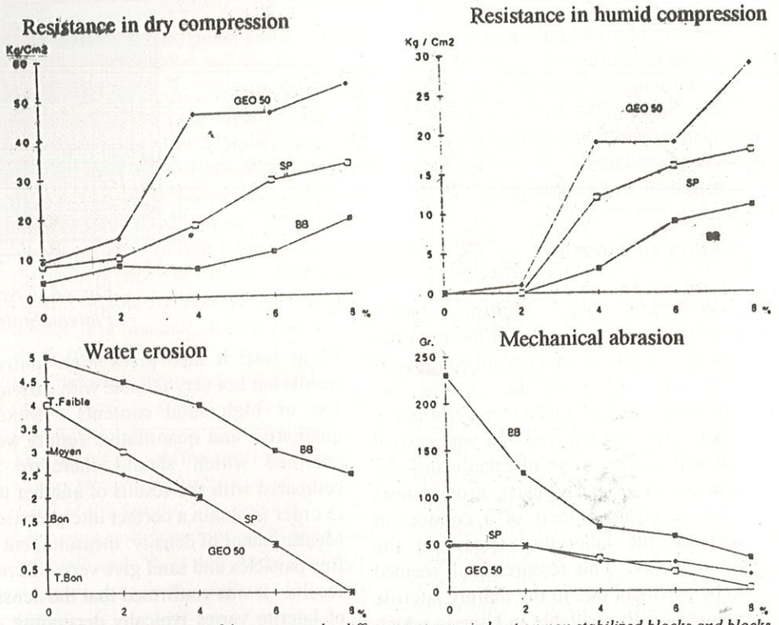

Fig. 68: Comparative tests of three presses by different tests carried out on non stabilized blocks and blocks stabilized at 2, 4, 6, and 8 % of cement.

Mechanical resistance to dry compression is tested with a site block breaker from the measurement of deflection breakage. Mechanical resistance in humid compression is measured after immersing the tested bricks in water for 24 hours. The resistance to abrasion is measured by the depth of sillon obtained after manual brushing and then mechanical brushing (40 passes). Resistance to erosion is measured by the depth of erosion after rain sprinkling with the shower head. Finally, capillary capacity is measured by the rising height of water after intervals of 5 minutes, 1 hour and 24 hours of immersion.

All these tests were experimented. They provide good results as regards the possibility of distinguishing blocks on the basis of adequately diversified, simple and therefore affordable measurements. The measurement of resistance to erosion alone needed to be improved since its precise measurement is difficult and is presently limited to a positive or negative observation. Depending on results which shall be obtained after a lot of tests, a description of classes of quality shall be attempted with particular reference to technical and constructive utilisation recommendations.

Fig. 69: Deflection breakage test measured with a site block breaker

Fig. 70: Abrasion test by metallic brushing

Fig. 71: Cappillary test

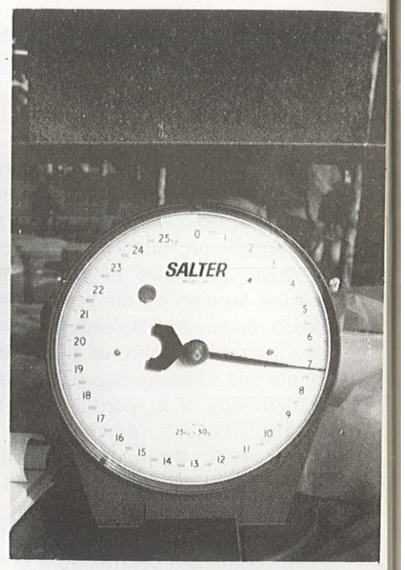

Fig. 72: Measurement of density by weighing bricks samples

Pathology and preservation

Observations noted on site, within the scope of the programme commenced since the end of 1988, emphasize the rapid deterioration of the building, housing and monumental heritage and modifies the collaboration maintained with the National Commission of Museums and Monuments towards studying solutions aimed at preserving this heritage as well as the definition of methods and techniques of maintenance. It will indeed be necessary to define and to implement solutions for the treatment of classic pathologies and, more extensively, solutions for protecting works so as to guarantee the duration of houses and the reduction of the financial maintenance burden.

Within the scope of these preoccupations, it was decided that observations on the nature of buildings in the Plateau area be completed by commencing a research on the pathology and preservation of buildings of the Museum of Traditional Nigerian Architecture of Jos. The MOTNA is indeed a rare example in Africa and, more extensively, in the world of a traditional architectural Museum which brings together, in one place, the main examples of application of the largest record of constructive cultures of a country.

The MOTNA, subject to physical, social and extreme climatic environmental constraints (high traffic load with usage degradation and violence of precipitation in the rainy season), draws up a list of buildings that were originally erected in different regions of the country and which withstand different environmental constraints (with constructive and architectural solutions suited to these environments) and presents a range of pathological phenomena likely to provide very interesting information on procedures of detection and degradation.

Two main objectives have been defined:

- understanding the process of erosion and the deterioration of MOTNA buildings and examples of regional and local housing architecture, as well as their detailed description and the establishment of a diagnostics of problems that were observed.
- definition and experimentation of technical protective or preservative solutions which will slow down the process of deterioration. These solutions ought to be simple, economical and should be reproduced easily at the level of the whole of the architectural museum.

On the aspect of methodology, the following is the procedure:

- observations made during the rainy season;
- collection of data on the different museum buildings particularly with their physical and climatic situations (locations, orientations, ground slopes);
- characterization of signs of erosion and deterioration accompanied with a diagnosis;
- confirmation of the process of erosion through experiments carried out on site;
- definition of technical maintenance and experimentation methods with analysis of results.

Observation of the development of the state of these buildings for two years now have been made possible through on-site missions. Throughout the year, the architect assigned to the Jos Museum supervises the programme. In this way, the work presently done has helped in the creation of a data base of observations (photographic follow-up of deterioration and erosion processes) which will constitute the basis necessary for a preliminary scientific analysis prior to the establishment of a diagnosis and the definition of maintenance methods which will be tested later on.

Adhering to the World Housing Strategy by the year 2 000

The "Earth Architecture in Nigeria" project and the development of activities linked to it from the CECTech in Jos were directly organised in the wake of the basic principles of the "World Housing Strategy by the year 2 000", (WHS), declared in December 1988 by the General Assembly of the United Nations and which, in Nigeria, inspired the definition of a specific "National Housing Policy" promulgated in February 1991. We recall here the most important orientations of the WHS to which the programme launched in Nigeria has pledged to adhere to. The initial results and contributions of the project to this strategy, explained in this booklet, should be appreciated in the light of these orientations which remain a precious guide for future developments in this project.

principle of adaptation

"A convenient accommodation for all is one which meets the specific cultural needs of the inhabitants and climate of a given place". (...) There is no universal standard as far as housing is concerned and the projection of standardized systems of industrialised countries in developing countries, far from bringing about appropriate solutions, only complicate the situation of housing in developing countries. The type of houses that is suited and specific to each country is necessary : they should be appropriated on the environmental level and affordable from the economic point of view, that is, realistic". (p.7).

"facilitation" principle

"The most important operational principle of the WHS is the "facilitation" approach through which the potential and resources of all the agents participating in the production and improvement of housing are mobilized. Essentially, the role of governments shall be to set up legislative, institutional and financial cadres who will ensure that companies from the formal and informal sectors, non-governmental associations, community and family associations contribute optimally to national systems of house construction. (...) The facilitation principle implies that the people concerned can improve their housing conditions depending on the needs and priorities that they would have defined themselves". (p.8).

principle of training and incitement

"One should be able to count on an adequate reservoir of staff trained and qualified for setting up a national programme of housing management. This concerns, not only high-level technical and administrative experts who are responsible for the design and orientation of the programme, but also contractors, craftsmen, workers and all who shall participate in the production, maintenance and functioning of the system of house construction and infrastructure, as well as members of the community who shall participate in decision making and in the process of implementation. A great effort in training has to be undertaken through the bias of various institutions using different methods and particularly vigorously supporting local training organisations.

Principle of creation of a favourable regulation

"While in the past, housing policies have rarely involved a systematic effort of revision of laws and regulations ruling the system of production of houses, the new housing strategies should envisage actions leading to reforms in regulations. (...) The review of codes and regulations in the area of land legislation, construction of houses and infrastructures are areas of high priority. (...) This will bring about the adaptation, or otherwise of new methods implemented in other countries. The elaboration of appropriate codes and standards of construction of low-income establishments, which can be gradually increased, must be envisaged.

Principle of stimulation of the building and construction materials sector

"Presently, the burden of provision of accommodation and infrastructure rests either on traditional technologies which are usually rudimentary and deficient or on modern technologies which are imported at an exorbitant cost and usually unsuitable. Criteria for the choice of a technology should include lowness of its initial cost, the aptitude of local labourers to use and maintain it and the practicability of its adaptation to local needs for eventual reproduction (p. 28).

"The main priority in the area of resources concerns the use of local materials and construction methods. For this, it could be necessary to resort to policies supporting investments in the following areas: research and evaluation of raw materials ; feasibility studies concerning the use of viable resources ; technical and research-development activities to evaluate, test and improve local materials and products ; promotion of products in the market ; study of regulation and methods of entering the market to identify obstacles which are against the acceptance and use of local materials. Appropriate measures should be taken to promote local production factors, particularly construction materials, labour and basic equipment. In addition, there is a need for the creation of research and training organisations or a reinforcement of the existing ones". (p. 29)

"Provision of basic construction materials can be rapidly increased at little cost by developing small scale production. Due to the adoption of recent technological innovations, it is now possible to set up a whole range of construction material industry relying exclusively on small production units. Consequently, the promotion of construction material production on a small scale is a concrete approach to the development of a self-sufficient industry of construction materials". (p. 30)

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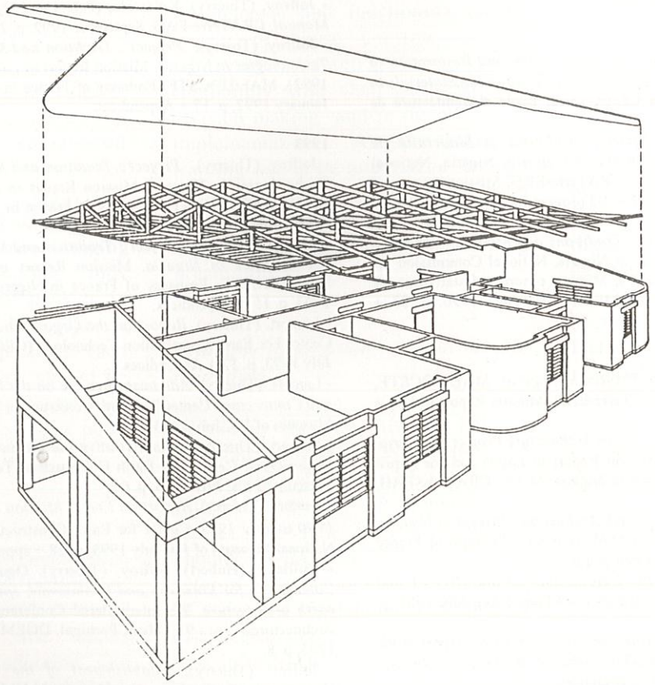
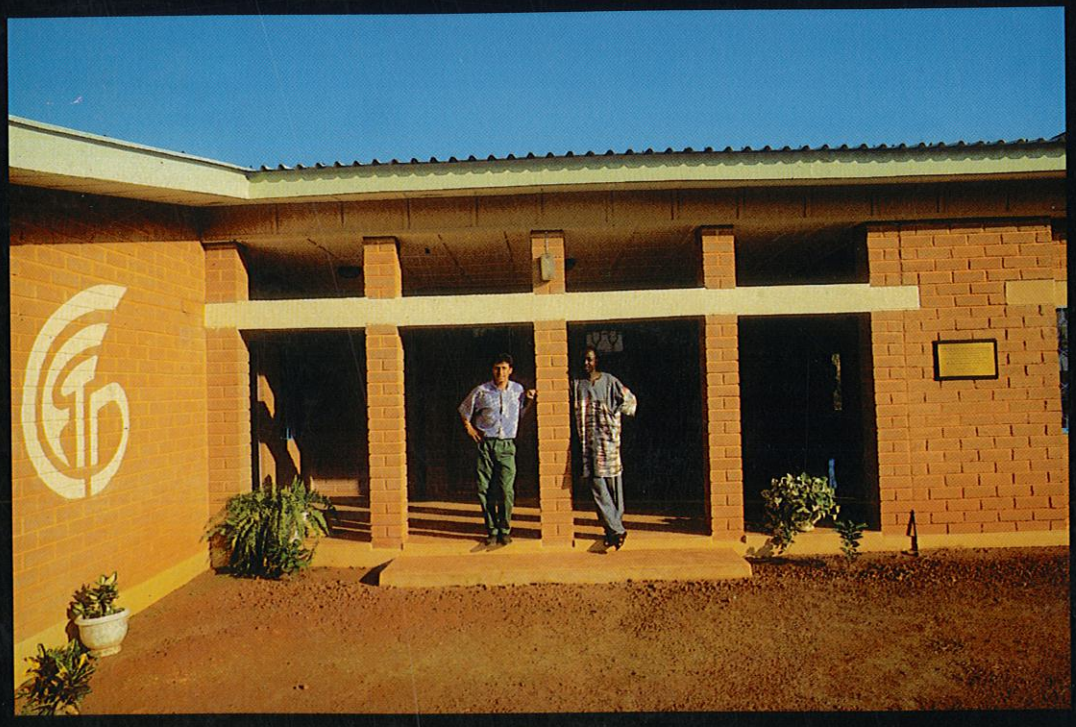


Fig. 73: Enlarged perspective of the demonstration house designed and built by CECTech, Jos



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